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SERIE: FISKERI · BIND VII

Nr. 5. A. C. Johansen: ON THE SUMMER- AND AUTUMN-SPAWNING HERRINGS OF THE NORTH SEA

KØBENHAVN
C. A. REITZEL, BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
1924

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ON THE SUMMER- AND AUTUMN-SPAWNING HERRINGS OF THE NORTH SEA

BY

DR. A. C. JOHANSEN

KØBENHAVN
C. A. REITZEL, BOGHANDEL
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I. Introduction.

In the present treatise I have tried to contribute to the knowledge concerning the racial characteristics of the summer- and autumn-spawning herrings of the North Sea and of the relation between these herrings and other sea herrings of the North Sea and adjacent waters.

Two classes of characters have been used by various authors to characterise the various races of fishes: those which, when once formed, remain constant during the whole life of the specimen (number of vertebrae, fin rays and keeled scales etc.), and those which are relative measures, as, for example, the length of head in proportion to the total length, the distance from the point of the snout to the anus in proportion to the total length, etc.

There is no doubt that the first mentioned group of characters present considerable advantages compared with the second group. The second group of characters may vary according to the different stages of development and are moreover influenced by the environment and perhaps by the state of preservation. Thus a considerable amount of uncertainty arises, the extent of which can not be determined without special investigations.

The experiences encountered in hatcheries etc. with young of the trout and other fishes placed under different environments induce us to be cautious in using the second group of characters as race characters. The same is the case with the experiences gained in the race studies of the common eel (*Anguilla vulgaris* Turton). Dr. Johs. Schmidt has shown (1914, 1916) that all eels from the whole of Europe belong to the same race, and yet it is a well-known fact that their appearance may be very different. The grown up eels vary not only in colour but also in shape, and even the skull is subject to great variations (Törlitz 1922). I have preferred therefore at the present stage of the investigations to employ only characters of the first mentioned group.

The following individual constant characters are taken up for statistical treatment in the present paper:

1) Number of vertebrae
   a. Total number of vertebrae (named *Vert. S.* = Vertebrarum Summa).
   b. precaudal vertebrae (the vertebrae in front of the first closed haemal arch).
   c. caudal vertebrae (Vert. S. *minus* Vert. præc.)
2) Number of keeled scales between the ventral fins and anus (K_2).
3) Number of fin rays in both ventral fins together.
4) Number of fin rays in dorsal fin. Only the branched rays are counted.
5) Number of fin rays in anal fin
   a. total number of fin rays
   b. number of branched fin rays
   c. number of unbranched fin rays.

Concerning the description of these characters I refer to two of my previous papers (A. C. Johansen 1919, 1921). Abnormal and defective specimens are omitted. When this is the case mistakes in the counting of any consequence can easily be avoided for the following characters:

Total number of vertebrae
Number of fin rays in ventral fins
Number of branched dorsal fin rays

Number of branched and unbranched anal fin rays.

If the skeletonising is not carried out with caution the foremost haemal arches may be damaged, and this can lead to mistakes in distinguishing between the caudal and precaudal vertebrae.

It is sometimes difficult to find the limit between the foremost and the hindmost keeled scales (K_1 and K_2), especially in small specimens. It will therefore be safest to reckon with the possibility of a few mistakes in case of small specimens. The foremost dorsal fin ray is sometimes rudimentary, and this offers a great difficulty in the counting of the unbranched rays. For this reason I have usually omitted the unbranched dorsal rays and counted only the branched ones.

For the calculation of σ the formula:

$$\sigma = \pm\sqrt{\frac{\Sigma p\,\alpha^2}{n-1}} = \pm\sqrt{\frac{1}{n\,(n-1)}}\sqrt{n\,\Sigma p a^2 - (\Sigma p a)^2}$$

is used throughout the work.

For the calculation of the correlation between two different characters we have employed PEARSON's formula $= \frac{\Sigma p\,\alpha_x \cdot \alpha_y}{\Sigma p'\,\alpha_x^2 \cdot \Sigma p''\,\alpha_y^2} = \frac{\Sigma p\,a_x \cdot a_y - n b_x \cdot b_y}{(n-1)\,\sigma_x \cdot \sigma_y}$; α_x and α_y indicate the deviation from the mean values for the two series; p is the number of variants for each separate class; a_x and a_y are the deviations from the chosen starting point for the calculation of the mean value; b_x and b_y indicate for each of the two series the distance between the true mean value, and the starting point for the calculation of the mean value. The total number of variants is indicated by n.

The characteristics used here of the different stages of maturity of the herring are in near agreement with HEINCKE's (1898). They are shown in the survey below.

Stage of Maturity	Female	Male
I. (Young virgin herrings)..	The height of the ovary is below 4 mm and the eggs can only be distinguished by help of the microscope. The colour of the ovary is whitish, greyish, or faintly reddish.	The height of testes is below 4 mm. The colour is whitish or greyish.
II. (Maturing herrings)	The height of the ovary is ca. 4—8 mm the eggs can be distinguished by help of a magnifying glass. The ovary is as a rule of a reddish colour.	The height of testes is 4—8 mm. The colour greyish or reddish grey.
III. (Maturing herrings)	The height of the ovary is ca. 8—15 mm. The eggs may be distinguished with naked eye. Their diameter is 0.2—0.5 mm. The ovary is as a rule of a reddish or yellowish colour.	The height of testes is 8—15 mm. The colour is greyish or reddish grey.
IV. (Full herrings).....	The ovary takes up a predominant part of the abdominal cavity. The eggs are 0.5—0.8 mm in diameter.	The height of testes is more than 15 mm. The colour is greyish white.
V. (Full herrings).....	The whole abdominal cavity is taken up by the ovary. The eggs about 0.8—1 mm in diameter or more.	Testes almost fill up the whole abdominal cavity. The colour is pure milky white.
VI. (Spawning herrings).....	The roe running.	Sperma running. The colour is milky white.
VII. (Spents or Blood-Herrings)	The ovary is empty or contains only a few residual eggs.	Testes baggy, bloodshot. Small remains of sperma may be present.
VIII. (Recovering Spents).....	The specimen has passed spawning some time ago. The eggs as in stage I—II, but the ovary is usually of greater dimensions.	The specimen has passed spawning some time ago. Testes bloodshot, no running sperma.

The stage VIII passes into the stage II or II—III. A stage which almost agrees with my stage VIII is indicated by HEINCKE as stage II a.

II. The Shetland Summer Herrings.

During the months from June to September a very considerable herring fishery based on summer-spawning herrings takes place in the waters surrounding the Shetland Isles. From June to the end of August the Shetland Herring is captured mostly as full herrings, and in September mostly as spent herrings. According to FULTON (1891) the spawning takes place during the months July to September in the environs of the Shetland Isles, for instance, at the south eastern part of Mainland. According to BJERKAN (1917) the spawning takes place in August—September on Unst Bank to Viking Bank in the North, and round Bressay Shoals in the South.

The Shetland Herring was made the subject of special race studies by the Norwegian zoologist HJ. BROCH who published his results in the treatise: "Norwegische Heringsuntersuchungen während der Jahre 1904—1906" (1908). Broch's material was collected partly from the Norwegian research steamer "Michael Sars", partly from the steamer "Kinn", and partly from the cutter "Frithjof". It originates from the northern part of the North Sea and adjacent parts of the Norwegian Sea between 59°—62° N. and 1° W. —3° E.

As a result of his investigations BROCH arrives at the conclusion that the Shetland Summer Herring belongs to a peculiar race, which, in certain respects, occupies an intermediate position between the Dogger Bank Herring and the Norwegian Spring Herring. As mean values for the number of vertebrae and keeled scales, Broch gives the following figures:

	Total number of Vertebrae	Number of keeled scales (K_2)
The Dogger Bank Herring	56.45	14.63
The Shetland Summer Herring	56.70	14.44
The Norwegian Spring Herring	57.60	c. 14.11

Broch makes the following remarks concerning his determinations of the maturity of the herring (l. c. p. 13—14):

"In den unsern Observateuren mitgeteilten Instruktionen werden die Entwickelungsstufen der Geschlechtsorgane auf folgende Weise eingeteilt:

I. Hering der nie gelaicht hat. Bei diesem liegen die Geschlechtsorgane, die in der Regel in Fett begraben sind, dicht unter der Wirbelsaüle; es ist unmöglich mit dem blossen Auge zu entscheiden, welchem Geschlecht sie angehören. Die Höhe der Geschlechtsorgane überschreitet nicht 2—3 mm.
II. Höhe der Geschlechtsorgane 3 bis 9 mm (3 mm bis $^1/_3$ Zoll.).
III. Höhe der Geschlechtsorgane 9 bis 18 mm ($^1/_3$ bis $^2/_3$ Zoll.).
Die einzelnen Eier in den Ovarien sind klein und eckig; keine klaren Eier.
IV. Höhe der Geschlechtsorgane über 18 mm ($^2/_3$ Zoll.). Testes ganz milchweiss, Sperma nicht fliessend, die Ovarien mit einzelnen, zerstreuten, hellen Eiern.
V. Sperma und Eier fliessend.
VI. Ausgelaicht (Bluthering wird mit einem hinzugefügten b. bezeichnet).

In zweifelhaften Fällen werden Zwischenstadien angegeben (z. B. II—III).

Wenn man diese Tabelle mit HEINCKE's [l. c. 1898] vergleicht, fällt sogleich eine Grundverschiedenheit auf; seine Einteilung erfordert, dass dem Untersucher eine Lupe zur Verfügung steht und es ist notwendig, dass er grosse Übung besitzt wenn er mit einiger Schnelligkeit die Einteilung von HEINCKES Entwickelungsstadien anwenden können soll. Gerade dieser Umstand erforderte für uns eine Änderung der Einteilung. Unsere Observateure waren Fischer, und es war unmöglich ihnen auf einem Laboratorium Gelegenheit zu längeren Übungen zu geben; dazu kommt, dass die Zeit die auf einem Heringsfischerboot

für diese Art Arbeiten angewendet werden kann, sehr knapp bemessen ist, und es war nötig, innerhalb kürzester Zeit möglichst viele Individuen untersuchen zu können. Aus diesem Grunde war es nötig die Höhenmessungen der Geschlechtsorgane bei der Einteilung ihrer Entwickelungsstufen einzuführen . . ."

The herrings investigated by Broch, which, according to his opinion, belonged to the Shetland Summer Herring, were captured in the months September, October and November, and they are nearly all indicated as being of maturity VI (Broch's scale). Other herrings were captured at the same time of maturity II and III which, according to Broch's opinion, belonged to the Norwegian Spring Herring.

A survey will be found below showing the results of Broch's analyses with regard to the characters constant for the individual:

Analyses, according to Broch, of Shetland Herrings.

Date	Place of capture	No. of spec.	Average length	Vert. S.	Vert. præc.	K_2	Rays in both ventr. fins	Maturity (Broch's scale)
13/IX 1904	ca. 61° 51′ N., 0° 45′ E.	32	30.66	56.94	23.59	14.41	..	(V) VI, (II—III)
14/X 1904	Viking Bank	60	30.65	56.62	23.73	14.39	..	VI
27/X 1904	—	16	30.21	56.63	23.31	14.25	17.62	VI
1/XI 1904	—	20	29.36	56.65	23.60	14.60	17.95	VI
2/XI 1904	—	2	30.95	58.00	24.00	14.50	17.50	VI
	Total	130	30.40	56.73	23.63	14.41	17.76	

For the three latter samples the material is given in detail and the following table shows the extent of the variation.

Vert. S.		Vert. præc.		K_2		Rays in both ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	1	22	4	13	3	15	1
56	15	23	14	14	18	16	3
57	18	24	17	15	15	17	1
58	3	25	3	16	1	18	32
..	..	..	..	17	1	19	1
60	1	..	..	..	..	..	..
n	38		38		38		38
m	56.71		23.50		14.45		17.76
σ	0.87		0.80		0.85		0.75
σ_m	0.14		0.13		0.13		0.12
σ_σ	0.10		0.09		0.09		0.09

We shall consider here another of Broch's analyses of summer-spawning herrings from the northern part of the North Sea (l. c. 1908).

Broch examined 29 herrings of maturity VII (Broch's stage VI) of a length of 26—32 cm, aver. 28.8 cm captured from "Michael Sars", on September 10. 1904 at Station VII ca. 40 miles S. E. of Fair Isle at 59° 14′ N. and 0° 38′ W. The analysis gave the following result:

Vert. S.		Vert. præc.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
56	14	23	11	13	2	15	1
57	15	24	14	14	10	16	..
..	..	25	3	15	15	17	4
..	..	26	0	16	2	18	24
..	..	27	1	..	..	..	..
n	29		29		29		29
m	56.52		23.83		14.59		17.76
σ	0.51		0.89		0.73		0.64
σ_m	0.09		0.16		0.14		0.12
σ_σ	0.07		0.12		0.10		0.08

Broch also referred this herring to the Shetland Summer Herring. It will be seen that in this group the mean figure for Vert. S. is somewhat lower and the mean figure for keeled scales somewhat higher than for Broch's other Shetland Herrings.

Heincke (l. c. 1898) investigated a sample of summer-spawning herrings which were captured at Fair Isle from an Emdener Logger on June 27. and 29. 1887. The herrings had a size from 24.6—30.8 cm, average 26.4 cm. Nearly all the specimens were of maturity III—VI, and the sample in its entirety was named Voll Heringe by Heincke. A few specimens were of maturity I—II, and quite a few had spawned (maturity VII). Heincke's analysis gave the following result for the individually constant characters:

Summer Herrings from Fair Isle, 27. and 29. June 1887 (Heincke):

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	5	22	1	31	1	13	5	16	1
56	35	23	11	32	13	14	19	17	6
57	31	24	16	33	12	15	39	18	67
58	4	25	2	34	4	16	10	19	1
..	..	..	..	..	..	17	2	..	..
n	75		30		30		75		75
m	56.45		23.63		32.63		14.80		17.91
σ	0.70		0.67		0.76		0.85		0.37
σ_m	0.08		0.12		0.14		0.099		0.043
σ_σ	0.057		0.09		0.10		0.070		0.031

Redeke (1918) has investigated a sample of herrings which was captured on the plateau East of the Shetland Isles at 60° 37.5′ N. 0° 41′ E. on June 23. 1906. The sample consisted of 50 specimens of a length from 24—27 cm. Redeke assigns to most specimens a maturity of II and for a smaller number that of I—II, II—III and III—IV. We may assume that the specimens of maturity II—III and III—IV are summer or autumn spawning herrings, and Redeke was of the opinion that the whole sample consisted of such herrings. The analysis gave for the individually constant characters the following result:

Vert. S.		Vert. præc.		Vert caud.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	1	23	10	30	2	12	1	16	3
56	20	24	24	31	4	13	2	17	1
57	22	25	13	32	15	14	18	18	46
58	7	26	2	33	25	15	21	..	..
..	..	27	1	34	4	16	4	..	..
..	..	..	..	..	..	17	4	..	..
n	50		50		50		50		50
m	56.70		24.20		32.50		14.74		17.86
σ	0.74		0.88		0.91		1.03		0.50
σ_m	0.10		0.12		0.13		0.15		0.07
σ_σ	0.074		0.088		0.091		0.103		0.050

As the samples of herrings from the area around the Shetland Isles which were investigated by Heincke and Redeke, seemed to differ from the samples investigated by Broch, the racial characteristics of the Shetland Summer Herring were exceedingly doubtful. For this reason I asked the Chairman of the Fishery Board for Scotland, Mr. D. T. Jones, to forward a sample of typical summer- or autumn-spawning Shetland Herrings for investigation, and Mr. Jones kindly complied with my wishes.

The Shetland Herrings which I have examined, were taken from a catch of 72 crans, which, according to information kindly supplied by Mr. Jones, was caught in drift nets 20 miles S. E. of Balta Sound (at abt. 60° 35′ N. 0° 13′ W.) on September 1st 1921. The sample consisted of 363 specimens of the following lengths:

cm	♂	♀	Total
25	1	1	2
26	13	12	25
27	40	37	77
28	47	86	133
29	22	60	82
30	10	25	35
31	3	6	9
Total	136	227	363
Average length [1]	28.37	28.78	28.63

[1] Corrected by adding 0.5.

Arranged according to maturity the herring fell into the following groups:

Maturity:	♂	♀	Total
III[1]	..	27	27
IV	..	70	70
IV—VI	135	..	135
V—VI	..	129	129
VII	1	1	2
	136	227	363

The results of the detailed analysis of the herring are given in the survey below:

Vert. S.		Vert. præc.		Vert. caud.		K_2	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
51	1	20	1	29	1	13	17
..	..	..	..	30	6	14	104
54	1	22	14	31	21	15	175
55	10	23	106	32	129	16	54
56	170	24	179	33	137	17	12
57	163	25	48	34	66	18	..
58	17	26	14	35	3	19	1
59	1	27	1	..	..	..	..
n	363		363		363		363
m	56.504		23.837		32.667		14.846
σ	0.718		0.882		0.941		0.882
σ_m	0.0377		0.0463		0.0494		0.0463
σ_σ	0.0267		0.0327		0.0349		0.0327

Rays in ventral fins (Both fins together)		Rays in dorsal fin. branched		Total		Rays in anal fin. branched		unbranched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
15	1	14	58	14	1	11	1	2	23
16	33	15	211	15	15	12	12	3	288
17	36	16	87	16	68	13	87	4	43
18	283	17	3	17	154	14	142	..	..
19	6	..	..	18	95	15	99	..	..
20	1	..	..	19	20	16	14	..	..
..	..	..	..	20	1	17	1	..	..
n	360		359		354		356		354
m	17.731		15.097		17.105		14.045		3.056
σ	0.669		0.655		0.948		0.930		0,429
σ_m	0.0353		0.0346		0.0504		0.0493		0.0228
σ_σ	0.0249		0.0244		0.0356		0.0349		0.0161

[1] The spawning of the specimens of maturity III would probably not take place earlier than October.

In order to investigate whether the specimens of different maturity and sex showed the same racial characteristics I have divided the material in the following way:

27	females	of	maturity	III
70	—	-	–	IV
130	—	-	—	V—VII
136	males	-	—	IV—VII

The analysis for the individually constant characters gives for these groups the following results:

27 Females of Maturity III. S. E. of Balta Sound. Septbr. 1. 1921.

Vert. S.		Vert. præc.		Vert. caud.		K_2	
55	1	23	5	31	1	13	2
56	13	24	19	32	11	14	6
57	10	25	3	33	12	15	17
58	3	..	..	34	3	16	2
n	27		27		27		27
m	56.56		23.93		32.63		14.70
σ	0.75		0.55		0.74		0.72
σ_m	0.14		0.11		0.14		0.14
σ_σ	0.10		0.07		0.10		0.10

Rays in ventral fins		Rays in dorsal fin. branched		Total		Rays in anal fin branched		unbranched	
17	1	14	5	15	1	12	1	3	23
18	26	15	15	16	5	13	6	4	4
..	..	16	7	17	11	14	12	..	..
..	..	..	..	18	9	15	8	..	..
..	..	..	..	19	1	..	..	..	..
n	27		27		27		27		27
m	17.96		15.07		17.15		14.00		3.15
σ	0.19		0.68		0.91		0.83		0.36
σ_m	0.04		0.130		0.17		0.16		0.07
σ_σ	0.03		0.092		0.12		0.11		0.05

70 Females of Maturity IV. S. E. of Balta Sound. Septbr. 1. 1921.

Vert. S.		Vert. præc.		Vert. caud.		K_2	
54	1	23	20	30	2	13	2
55	..	24	40	31	2	14	26
56	32	25	8	32	28	15	31
57	35	26	2	33	25	16	10
58	2	..	..	34	13	17	1
n	70		70		70		70
m	56.53		23.89		32.64		14.74
σ	0.63		0.71		0.92		0.79
σ_m	0.075		0.085		0.110		0.095
σ_σ	0.053		0.060		0.078		0.067

Rays in ventral fins		Rays in dorsal fin branched		Total		Rays in anal fin branched		unbranched	
16	6	14	7	14	1	11	1	2	4
17	7	15	49	15	4	12	3	3	57
18	57	16	13	16	13	13	19	4	8
..	..	..	..	17	32	14	25	..	..
..	..	..	..	18	14	15	18	..	..
..	..	..	..	19	5	16	3	..	..
n	70		69		69		69		69

m	17.73	15.09	17.00	13.94	3.058
σ	0.61	0.54	1.03	1.01	0.42
σ_m	0.073	0.064	0.124	0.122	0.050
σ_σ	0.052	0.046	0.088	0.086	0.035

130 Females of Maturity V—VII. S.E. of Balta Sound. Septbr. 1. 1921.

Vert. S.		Vert. præc.		Vert. caud.		K_2	
55	4	22	9	29	1	13	7
56	64	23	39	30	3	14	30
57	56	24	54	31	13	15	71
58	5	25	18	32	39	16	14
59	1	26	9	33	45	17	7
..	..	27	1	34	27	18	..
..	..	..	..	35	2	19	1
n	130		130		130		130
m	56.50		23.86		32.64		14.91
σ	0.66		1.02		1.09		0.94
σ_m	0.058		0.090		0.095		0.083
σ_σ	0.041		0.064		0.067		0.059

Rays in ventral fins		Rays in dorsal fin branched		Total		Rays in anal fin branched		unbranched	
15	1	14	23	15	5	12	3	2	12
16	17	15	74	16	24	13	27	3	103
17	16	16	32	17	49	14	47	4	9
18	90	17	1	18	39	15	39	..	..
19	2	..	..	19	6	16	7	..	..
20	1	..	..	20	1	17	1	..	..
n	127		130		124		124		124
m	17.61		15.08		17.16		14.19		2.98
σ	0.80		0.67		0.96		0.95		0.41
σ_m	0.071		0.059		0.086		0.085		0.037
σ_σ	0.050		0.042		0.061		0.060		0.026

136 Males of Maturity IV—VII. S.E. of Balta Sound. Sept. 1. 1921.

Vert. S.		Vert. præc.		Vert. caud.		K_2	
51	1	20	1	30	1	13	6
..	..	22	5	31	5	14	42
55	5	23	42	32	51	15	56
56	61	24	66	33	55	16	28
57	62	25	19	34	23	17	4
58	7	26	3	35	1	..	..
..	..	..	..	..	..	..	..
n	136		136		136		136
m	56.49		23.77		32.71		14.87
σ	0.81		0.87		0.84		0.89
σ_m	0.069		0.075		0.072		0.077
σ_σ	0.049		0.053		0.051		0.054

Rays in ventral fins		Rays in dorsal fin branched		Total		Rays in anal fin branched		unbranched	
16	10	14	23	15	5	12	5	2	7
17	12	15	73	16	26	13	35	3	105
18	110	16	35	17	62	14	58	4	22
19	4	17	2	18	33	15	34	..	..
..	..	..	..	19	8	16	4	..	..
n	136		133		134		136		134

m	17.79	15.12	17.10	13.98	3.11
σ	0.61	0.70	0.91	0.88	0.45
σ_m	0.052	0.060	0.078	0.076	0.039
σ_σ	0.037	0.043	0.055	0.053	0.028

It will be seen that the females of maturity III have a higher number of ventral fin rays, a somewhat higher number of vertebrae and a little lower number of keeled scales than the females of maturity V—VII. The material investigated is, however, not large enough for us to decide whether there is a difference of real importance or not. The females of maturity IV do not show any striking deviations from the females of maturity V—VII, and it will be noticed that there is no marked difference between males and females of the same maturity stage.

A comparison with the older material shows that the result of my analysis agrees with Heincke's but differs a little from Redeke's and essentially from Broch's analysis.

For one particular character the sample from Fair Isle differs a little from the sample which I have investigated. There is a difference in the number of ventral fin rays of 0.20 while the standard deviation of the difference is 0.057. Here, however, it must be remembered, that the standard deviation of the mean figure for the sample from Fair Isle is calculated on the basis of a proportionately small number of specimens ($\sigma_\sigma = 0.031$), so there is very little reason for laying much stress upon this difference.

Though the sample investigated by Redeke is rather small, and though the deviations from my analysis need not to be of real importance, it is, however, peculiar, that his sample shows a higher number of vertebrae (Vert. S. and Vert. præc.) and a lower number of keeled scales than the samples investigated by Heincke and me. The explanation of the difference is probably that Redeke's samples contained a few young specimens of Spring Herrings. It is by no means certain that specimens which, at the end of June, show the maturity stage I—II or II are summer- or autumn-spawning herrings.

Redeke supposed that the sample investigated by him belonged to the same race as the Dogger Bank Herring.

The differences, however, between the results of Broch's analysis on the one side and Heincke's and mine on the other are essential. In Broch's samples the herrings have a perceptibly higher number of vertebrae and a lower number of keeled scales than the samples investigated by Heincke and me. If we suppose that the standard deviation of Broch's mean figure for the 130 specimens from Vikingbank etc. is abt. 0.07, a comparison between Broch's analysis and mine gives the following result:

Difference between results of Broch's analysis of Shetland Herring 1904 (130 specimens) and Johansen's of Shetland Herring 1921 (363 specimens):

Diff.	Vert. S.	0.23	St. Dev.	Diff.	0.08
—	Vert. præc.	—0.21	-	—	—	0.08
—	K_2	—0.44	-	—	—	0.08

The question is now: Has Broch dealt with a summer spawning herring belonging to a race different from that examined by Heincke and me, or has he dealt with the same race mixed with winter or spring herrings. It seems that Broch has dealt with a herring race differing from that examined by Heincke and me. A mixture of specimens of this last race with specimens of the Norwegian Spring Herring or the Shetland Spring Herring could show a similar number of Vert S. and of K_2 as that found by Broch, but it would show a higher number of precaudal vertebrae, as both the components of the mixture have a higher number of such vertebrae than that found by Broch (comp. Chap. XI). As there is evidence to hand that the herring race established by Broch is bound mainly to deep water in the northern part of the North Sea, I propose to name it: The North Sea Deep Water Herring, and to apply the name of Scotch Summer Herring to the race examined by Heincke and me (comp. Chap. III). The specimens from "Michael Sars" St. VII (59°14′ N., 0°38′ W. September 10. 1904) which are mentioned on p. 6—7, may belong to the Deep Water Herring.

III. The Scotch Summer Herring.

It is a well known fact that the great herring fisheries in the North Sea in summer and autumn off the eastern coasts of Scotland and England from the Orkneys to Flamborough Head are mainly based on a summer- or autumn-spawning herring. As KYLE has pointed out in his treatise: "Monthly Data and Charts over the Herring Fishery in 1903" (1906), the fishery for this herring commences in the month of June at the Orkneys and the northern coasts of Scotland after which it extends southwards. In July it is carried on in the area east of Scotland up to about 100 miles from shore, and in August it extends southwards past Flamborough Head. In September the fishery is greatly diminished off the coasts of Scotland, and north east England.

The spawning period for the Scotch Summer Herring is, according to FULTON (1891), MASTERMAN (1896), and BOWMAN (1923), mainly the months July, August and September, in the same months therefore during which the great fisheries take place. The mature specimens of the Scotch Summer Herring vary as a rule in length from about 22—32 cm, and the average length is in most catches about 25—28 cm.

We shall now examine the most important of the samples of the Scotch Summer Herring investigated by HEINCKE, BROCH, and REDEKE.

HEINCKE (1898) investigated 24 full herrings of a length 24—30 cm and of maturity IV—VI captured on the east coast of Scotland off Peterhead in August of 1871. The investigation showed the following distribution of the variants for keeled scales and rays in the ventral fins:

K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.
13	2	17	5
14	1	18	17
15	20	19	1
16	1	..	..
n	24		23
m	14.83		17.83
σ	0.63		0.49
σ_m	0.13		0.10
σ_σ	0.09		0.07

BROCH investigated 31 herrings captured off the Firth of Forth on "Michael Sars" St. VI at about 56°08′ N. and 0°05′ E. on September 8. 1904. The lengths of the herrings varied from 231 to 307 mm (aver. 254 mm) and BROCH indicates the stage of maturity for most specimens as II—III or III. Broch's analysis gave the following result: (l. c. 1908)

Vert. S.		Vert. præc.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	2	22	2	13	2	13	1
56	15	23	7	14	7	..	..
57	12	24	17	15	19	15	1
58	2	25	5	16	3	..	..
..	..	..	..	..	..	17	5
..	..	..	..	..	..	18	23
..	..	..	..	..	..	19	1
n	31		31		31		31

m	56.45	23.81	14.74	17.61
σ	0.72	0.79	0.73	1.09
σ_m	0.13	0.14	0.13	0.20
σ_σ	0.09	0.10	0.09	0.14

Broch referred this herring to the Dogger Bank Herring.

Redeke (l. c. 1918) investigated 50 herrings captured in Moray Firth on July 18th and 19th, 1906. The average length of the herrings was 24.7 cm and the stage of maturity varied from II—IV. The analysis gave, for the individually constant characters, the following results:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	2	23	17	31	1	13	1	16	3
56	21	24	29	32	17	14	15	17	2
57	24	25	4	33	24	15	29	18	45
58	3	..	..	34	6	16	5	..	..
..	..	..	..	35	2	..	..	..	..
n	50		50		50		50		50
m	56.56		23.74		32.82		14.76		17.84
σ	0.67		0.60		0.83		0.66		0.51
σ_m	0.10		0.08		0.12		0.09		0.07
σ_σ	0.07		0.06		0.08		0.07		0.05

Redeke referred this herring to the Dogger Bank Herring.

It will be noticed that all the samples of herring represented here, are in close agreement with the Summer Herring from Balta Sound investigated by me (comp. Chap. II).

IV. The Dogger Bank Herring.

In the middle part of the North Sea, especially around the southern and western part of the Dogger Bank, and between the Dogger Bank and the English coast, a great fishery takes place in September, October and November. It is based on an autumn spawning herring which has its spawning places in the neighbourhood of the areas where the greatest fisheries occur, and its spawning time in the period during which the main catch takes place.

Redeke (1918) has investigated the stage of maturity of herrings from the Dogger Bank at different times during the spawning period, and he found that it is not till about the middle of October that the majority of the specimens have spawned[1].

Heincke (1898) has investigated a small sample of herrings captured on the eastern part of the Dogger Bank at 55° 10′ N. 3° 40′ E. on September 9. 1890. The sample consisted of 5 specimens of a length of 24—27 cm and of the maturity stage V—VI. The distribution of the variants was as follows:

Vert. S.		Vert. præc.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
56	1	23	2	15	5	18	5
57	4	24	2	..	..	..	..
..	..	25	1	..	..	..	..
n	5		5		5		5
m	56.80		23.80		15.0		18.0

Broch (1908) investigated 31 specimens of an autumn-spawning herring captured between the Great Fisher Bank and Dogger Bank on September 5. 1904 ("Michael Sars" St. IV. 56° 16′ N. 5° 16′ E.). The average length of the herrings was 25.2 cm, and the stage of maturity III, rarely IV. From his analyses he

[1] In October 1904 Redeke investigated 64 haddocks captured on the Dogger Bank and found that in 60 of these the stomach contained herring eggs.

obtained the following mean figures: Vert. S. = 56.32, Vert. præc. = 23.90, K_2 = 14.31. Broch does not give the analyses in detail, but the standard deviation of his mean figures may be estimated to be about 0.14.

Broch referred this sample to the Dogger Bank Herring, but its low number of keeled scales makes it very improbable that it should belong to that race. It seems more probable that the sample belongs to the Jutland Bank Herring (comp. Chap. V).

Broch examined 31 herrings captured on September 6. 1904 on the western part of the Dogger Bank at "Michael Sars" St. V. at 54° 47′ N. and 1° 18′ E. Their average length was 256 mm and the maturity stage was as a rule II—III, more rarely IV. The analysis of the data is not given in detail, but the means are as follows:

Vert. S.	56.58
Vert. præc.	23.74
K_2	14.84

The standard deviation for these means may be estimated to be about 0.14.

Delsman (1914) investigated the number of vertebrae of 156 autumn spawning herrings captured on the Dogger Bank on October 3. 1911 and on September 14. 1912. The result of his analyses was as follows:

Dogger Bank, 54° 30′ N. 1° 25′ E. Oct. 3. 1911.

Length 22—30 cm (aver. 27.0). Maturity (Heincke's scale) III, IV (V, VI).

Vert. S. No.	Freq.		
55	4	m	56.43
56	55	σ	0.62
57	44	σ_m	0.060
58	3	σ_σ	0.042
n	106		

Dogger Bank, 54° 35′ N. 1° 32′ E. Septbr. 14. 1912.

Length 23—30 cm (aver. 27.2). Maturity (III), IV, V (VI).

Vert. S. No.	Freq.		
55	1	m	56.54
56	23	σ	0.61
57	24	σ_m	0.087
58	2	σ_σ	0.061
n	50		

Redeke investigated 40 herrings captured north west of the Dogger Bank at 55° 36′ N. and 0° 10′ E. on August 19. and September 3. 1906. The specimens were of an average length of 25.2 cm. The maturity stage was for most specimens III and IV. The analysis gave the following result:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	1	23	13	29	3	14	10	16	2
56	19	24	14	30	1	15	24	17	3
57	19	25	7	31	6	16	6	18	35
58	1	26	2	32	10	..	..	..	..
..	..	27	3	33	14	..	..	..	..
..	..	28	1	34	6	..	..	..	..
n	40		40		40		40		40
m	56.50		24.28		32.23		14.90		17.83
σ	0.60		1.32		1.37		0.63		0.50
σ_m	0.09		0.21		0.22		0.10		0.08
σ_σ	0.07		0.15		0.15		0.07		0.06

Redeke investigated 25 herrings captured on the Dogger Bank at 54° 30′ N. 2° 40′ E. on October 11. 1906. The average length of the specimens was 26.4 cm and the stage of maturity of the majority of the specimens varied from III to V—VI. The analysis of the specimens gave, for the characters which I consider, the following result:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	1	23	7	30	2	12	1	15	1
56	13	24	12	31	3	13	..	16	..
57	10	25	4	32	9	14	2	17	1
58	1	26	2	33	6	15	10	18	22
..	..	..	..	34	4	16	11	19	1
..	..	..	..	35	1	..	..	..	..
n	25		25		25		24		25
m	56.44		24.04		32.40		15.25		17.88
σ	0.65		0.89		1.26		0.94		0.67
σ_m	0.13		0.19		0.25		0.19		0.13
σ_σ	0.09		0.13		0.18		0.14		0.09

Both samples taken together give the following result:

Dogger Bank Herring investigated by Redeke.

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	2	23	20	29	3	12	1	15	1
56	32	24	26	30	3	..	..	16	2
57	29	25	11	31	9	14	12	17	4
58	2	26	4	32	19	15	34	18	57
..	..	27	3	33	20	16	17	19	1
..	..	28	1	34	10	..	..	..	..
..	..	..	..	35	1	..	..	..	..
n	65		65		65		64		65
m	56.48		24.18		32.29		15.03		17.85
σ	0.62		1.17		1.32		0.78		0.57
σ_m	0.08		0.15		0.16		0.10		0.07
σ_σ	0.054		0.103		0.116		0.069		0.050

It is probable that the herrings mentioned here have their spawning places on the very Dogger Bank or in the area between the Dogger Bank and the English coast.

The herrings mentioned here from the area around the Dogger Bank are evidently nearly related to the Scotch Summer Herring. As stated in Chapter VII the Dogger Bank Herring has usually a little higher number of keeled scales (K_2) than the Herrings from the north western areas of the North Sea.

Redeke (l. c. 1918) considered the samples which he had investigated from the Shetland Isles and Moray Firth to belong to the same race as the Dogger Bank Herring.

The "Yarmouth-Lowestoft Herring" which is caught in the south-western part of the North Sea (especially between 52—53° N. and 2—3° E.) in October, November and December, consists mainly of winter spawning herrings, which belong to the Channel Sea Herring (see Chap. XI). The autumn spawning herrings are of little importance in the area where the "Yarmouth-Lowestoft Herring" is mainly caught. Redeke (1918) has investigated 3 autumn spawners of maturity VII caught at 53°06′ N. 3° E. on November 7. 1906 and has found the following numbers of vertebrae etc.:

No.	Total length mm	Vert. S.	Vert. præc.	K_2	Rays in both ventral fins
1	270	57	24	15	18
2	245	57	24	15	18
3	242	55	23	14	18
Average	25.2	56.33	23.67	14.67	18.00

The number of specimens investigated by Redeke is too small to allow us to decide to which race they belong, but they harmonize very well with the Dogger Bank Herring.

From analyses carried out by Heincke and me it appears that in the eastern part of the North Sea young herrings occur which are in very close accordance with the Dogger Bank Herring, and as the prevalent currents will tend to transport a great deal of the small larvae from the spawning places of the Dogger towards the waters west of Jutland (comp. Fig. 5) it is also probable that many of the Dogger Herrings grow up there.

The results of some analyses of young herrings from these waters are given below.

HEINCKE examined a sample of young herrings of a length of 13—17 cm and of maturity I captured west of Sylt at 54° 55′ N. 6° 34′ E. on August 4th 1889. The analysis gave the following result:

Vert. S.		Vert. præc.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
54	1	22	2	14	10	16	2
55	0	23	3	15	13	17	4
56	12	24	11	16	7	18	22
57	16	25	7	..	..	19	1
58	1	26	5	..	..	20	1
n	30		28		30		30
m	56.53		24.36		14.90		17.83
σ	0.73		1.13		0.76		0.75
σ_m	0.13		0.21		0.14		0.14
σ_σ	0.09		0.15		0.10		0.10

This sample agrees in every respect with the typical Dogger Bank Herring.

From the west coast of Jutland off Thyborön I have had for investigation a large sample of young herrings which were captured on July 16. 1918. The number of vertebrae and of keeled scales were investigated in 200 specimens of a length of 5—9 cm. Moreover the number of vertebrae was counted in 140 specimens of 6—11 cm length.

The analysis gave the following result:

200 specimens 5—9 cm.

Vert. S.		K_2	
No.	Freq.	No.	Freq.
54	2	13	4
55	13	14	51
56	95	15	83
57	83	16	53
58	7	17	7
..	..	18	1
..	..	19	1
n	200		200
m	56.40		15.08
σ	0.71		0.93
σ_m	0.050		0.066
σ_σ	0.035		0.046

The length and the number of vertebrae of the 140 specimens were as follows:

Length cm.		Vert. S.	
6	5	55	4
7	41	56	68
8	53	57	64
9	22	58	3
10	15	59	1
11	4	..	..
n	140		140

m	8.09 + 0.5	56.49
σ	1.13	0.63
σ_m	0.096	0.053
σ_σ	0.068	0.038

Taking the vertebrae of the two groups together we get the following result:

Vert. S. No.	Freq.		
54	2	m	56.44
55	17	σ	0.68
56	163	σ_m	0.037
57	147	σ_σ	0.026
58	10		
59	1		
n	340		

It appears that this herring with regard to the keeled scales and vertebrae is probably in full accordance with the Dogger Bank Herring.

V. The Jutland Bank Herring.

The Jutland Bank Herring has its spawning places on the Little Fisher Bank, the Jutland Bank, and adjacent parts of the Skagerak, and the spawning period is September—October.

Heincke (1898) proved the occurrence of ripe autumn spawning herrings N. E. of Jutland Bank at 57° 20′ N, and 7° 56′ E. on September 12. 1889, and in 1903 Duge stated that the stomach of the haddock and the frogfish (*Lophius piscatorius*) captured on the Little Fisher Bank and the Jutland Bank between September 30. and October 4. 1903 contained herring eggs. — In September and October 1922, I found that young herring fry occurred in the neighbourhood of the Little Fisher Bank, the Jutland Bank and the south western Skagerak (see Figs. 1 and 2).

Heincke examined a sample of herrings captured on September 12. 1889 N. E. of the Jutland Bank at 57° 20′ N. 7° 56′ E. (1898 p. 72), and he ascribed the following stages of maturity to 30 specimens:

Length cm	I	V	VI	VI—VII
24	..	..	2	..
25	1	..	2	..
26	..	..	..	..
27	..	1	6	..
28	..	..	5	..
29	..	1	4	..
30	..	..	6	..
31	..	..	1	1
	1	2	26	1

The mature specimens had an average size of 28.6 cm. The immature specimen of 25 cm (maturity I) had 58 vertebrae, 14 keeled scales and 18 ventral fin rays. In all probability it belonged to the Norwegian Spring Herring. The frequency distribution of the 29 specimens of maturity V—VII for the number of vertebrae, keeled scales and ventral rays was as follows:

Vert. S.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.
55	1	13	3	16	3
56	11	14	11	17	3
57	17	15	11	18	22
..	..	16	4	19	1
n	29		29		29

m	56.55	14.55	17.72
σ	0.58	0.87	0.70
σ_m	0.11	0.16	0.13
σ_σ	0.075	0.11	0.092

HEINCKE investigated 26 young herrings of maturity I—II and of 14—24 cm length captured 28 miles N. by W. of Hanstholm on August 12. 1889. He found the following numbers of vertebrae etc.: Vert. S. = 56.31 ± 0.14; Vert. præc. = 23.81 ± 0.21; vert. caud. = 32.50 ± 0.17; $K_2 = 14.73 \pm 0.17$; Rays in ventral fins = 17.81 ± 0.17.

The Jutland Bank Herring is not sufficiently characterized by the investigations carried out hitherto, but it seems probable that it is closely related to the Scotch Summer Herring.

VI. Autumn Herrings from the German Bight.

In the German Bight autumn herrings occur which usually are of little importance but sometimes may be numerous. HEINCKE writes as follows about these herrings (1898 I[1] p. LXII—LXIII): "während die Herbstheringe der nördlichen Nordsee in ungeheuren Schwärmen auftreten und den Gegenstand einer grossartigen Fischerei bilden, sind die Schwärme der Herbstheringe der südlichen Nordsee klein und individuenarm. Namentlich gilt dies von der südöstlichen Nordsee oder der deutschen Bucht. Es ist jedoch wahrscheinlich, dass dem nicht immer so gewesen ist, dass es vielmehr Zeiten gegeben hat, z. B. der Anfang dieses Jahrhunderts, wo grössere fangwürdige Mengen von Herbstheringen in der deutschen Bucht vorhanden waren. Es ist auch wahrscheinlich dass eine solche Zeit einmal wiederkehren wird".

A sample of mature herrings described by HEINCKE was captured south of Horns Reef at 55° 26′ N. 6° 50′ E. on September 13. 1890. The specimens were of maturity V—VI and their lengths were as follows:

cm	♂	♀
22	1	..
23	..	..
24	3	1
25	4	2
n	8	3
m	24.2 + 0.5	24.7 + 0.5

It will be seen that the average length of the specimens was smaller than is usually the case in the mature Dogger Bank Herring.

The analysis gave for the individually constant characters the following result:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
56	6	23	4	29	1	14	5	16	2
57	5	24	3	30	2	15	4	17	..
..	..	25	1	31	0	16	2	18	9
..	..	26	2	32	2	..	..	..	..
..	..	27	1	33	4	..	..	..	..
..	..	..	..	34	2	..	..	..	..
n	11		11		11		11		11
m	56.45		24.36		32.09		14.73		17.64

From this small sample we are not able to judge whether the German Bight Herring differs from the Dogger Bank Herring or not, but some analyses of young herrings caught in the German Bight suggest that we have here to do with an autumn spawning herring which differs from the Dogger Herring by a somewhat smaller number of Vertebrae (Vert. S.).

We will here consider some analyses of such young herrings.

A sample investigated by me, consisting of young herrings of a length of 8—10 cm, maturity I, captured from the "Dana" by otter-trawl south of Horns Reef at 55° 20′ N. 7° 20′ E. on September 19th 1922, showed the following distribution of the variants:

Vert. S.		Vert. præc.		Vert. caud.	
No.	Freq.	No.	Freq.	No.	Freq.
55	5	22	2	30	3
56	37	23	21	31	9
57	20	24	28	32	19
58	3	25	10	33	27
..	..	26	3	34	7
..	..	27	0	..	..
..	..	28	1	..	..
n	65		65		65
m	56.32		23.92		32.40
σ	0.69		1.02		0.01
σ_m	0.085		0.13		0.13
σ_σ	0.060		0.09		0.09

The survey below shows the distribution of the variants for the vertebrae etc. of 50 young herrings of lengths of 9—11 cm caught by herring trawl from the "Dana" southwest of Graadeep at 55° 23′ N. 8° 12′ E. on November 30. 1922:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	2	22	1	30	1	14	12	16	4
56	29	23	13	31	5	15	17	17	9
57	16	24	24	32	22	16	19	18	36
58	3	25	10	33	18	17	2	19	1
..	..	26	2	34	2	..	..	..	..
..	..	..	..	35	2	..	..	..	..
n	50		50		50		50		50
m	56.40		23.98		32.42		15.22		17.68
σ	0.67		0.84		0.95		0.86		0.65
σ_m	0.09		0.12		0.13		0.12		0.09
σ_σ	0.07		0.08		0.09		0.09		0.07

The scales proved to be without winter ring. We are evidently concerned here with autumn herrings of the year class 1921.

HEINCKE has investigated some samples of young herrings captured at the mouth of Elbe, where there is a possibility of an intermixture with spring spawners. The high number of keeled scales suggests, however, that the possible intermixture of spring spawners cannot be of much importance. The analysis of 105 specimens of a length of 8—23 cm and maturity I—II, captured on November 30th 1877, November 17. 1886, December 1891, February 2. 1887, March 22. 1889 and March 11, 1891 has given the following results for the individual constant characters:

Vert. S.		Vert. præc.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.[1]	Freq.	No.[2]	Freq.
55	7	22	4	13	3	16	5
56	38	23	12	14	20	17	8
57	29	24	18	15	57	18	91
58	2	25	7	16	22	19	1
..	..	..	..	17	1	..	..
..	..	28	1	..	..	..	..
n	76		42		103		105
m	56.34		23.79		14.98		17.84
σ	0.68		1.09		0.75		0.50
σ_m	0.08		0.17		0.07		0.05
σ_σ	0.06		0.12		0.05		0.03

[1] One specimen with 20 K_2 omitted as abnormal.

[2] - — — 11 Ventr. fin rays omitted as abnormal.

A sample investigated by HEINCKE consisted of young herrings of 9—14 cm length captured off Helgoland on October 3. 1894. The distribution of the variants was as follows:

Vert. S.		Vert. præc.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
56	13	23	4	13	2	13	1
57	11	24	15	14	8	14	1
58	1	25	5	15	9	15	1
..	..	..	..	16	5	16	2
..	..	..	..	17	1	17	3
..	..	..	..	..	..	18	16
n	25		24		25		24
m	56.52		24.04		14.80		17.21
σ	0.59		0.62		1.00		1.41
σ_m	0.12		0.13		0.20		0.29
σ_σ	0.08		0.09		0.14		0.20

It will be noticed that the average number of rays in the ventral fins is here unusually low.

HEINCKE investigated 17 young herrings captured North of Terschelling at 53° 45′ N. 4° 47′ E. on September 4th 1890. The specimens were of length from 13—16 cm and of maturity I. The analysis gave the following result:

Vert. S.		Vert. præc.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
54	1	23	8	14	3	17	3
55	1	24	7	15	11	18	14
56	9	25	2	16	2	..	..
57	5	..	..	17	1	..	..
58	1	..	..	..	..	..	..
n	17		17		17		17
m	56.29		23.64		15.06		17.82

The high number of keeled scales makes it improbable that these herrings should belong to the Channel Sea Herring or local races of spring herrings from the Zuider Zee or the southern part of the North Sea.

It will be seen that in all these samples, except one, the number of vertebrae is somewhat lower than in the Dogger Bank Herring and the Scotch Summer Herring. It might be suggested that the low number of vertebrae in the case of the young herrings examined could originate from an intermixture with local spring spawners, but that such an intermixture is of any consequence is improbable on account of the high number of keeled scales found in the samples.

It is possible that some of the samples of the young herrings investigated may be Dogger Bank Herrings, but it is improbable that all the samples should belong thereto.

From the analyses to hand we gain the impression that the autumn spawning herrings of the German Bight have a similar high number of keeled scales as the Dogger Bank Herring but a somewhat lower number of vertebrae. The average number of vertebrae in 244 specimens was 56.36 against 56.49 in the Dogger Bank Herring. (257 spec.)

The spawning places for the autumn herrings from the German Bight are not known as yet.

VII. General Survey of the Racial Characteristics of the Summer- and Autumn-Spawning Herrings of the North Sea.

It appears from the analyses mentioned in Chap. II—IV that a part of the Shetland summer herrings belongs to the same race as the Scotch Summer Herring, and that we have only been able to point out very small — and perhaps not constant — differences, in the individual constant characters between the Scotch Summer Herring and the Dogger Bank Herring. The Jutland Bank Herring is not yet sufficiently known, but it seems probable that this herring is in close agreement with the Scotch Summer Herring. We will therefore refer all these herrings to one single race and use a common name for them all: The Bank Herring of the North Sea. This herring may be characterized provisionally by the following average numbers of vertebrae, keeled scales, rays in ventral fins and rays in dorsal and anal fins (Comp. Table 9, p. 84):

Total number of Vertebrae	56.50 ± 0.05
Number of precaudal Vertebrae	23.90 ± 0.07
— - caudal Vertebrae	32.60 ± 0.07
— - keeled scales (K_2)	14.85 ± 0.07
— - fin rays in both ventral fins	17.75 ± 0.05
— - branched dorsal fin rays	15.20 ± 0.10
Total number of anal fin rays	17.20 ± 0.10

The Bank Herrings from various parts of the North Sea are evidently in close agreement with each other as to the morphological characters. It appears, however, from the survey below, that the Bank Herrings from the north western part of the North Sea have usually a little lower number of keeled scales than the Bank Herrings from the Dogger Bank and adjacent areas to the East.

Number of Keeled Scales (K_2) and Precaudal Vertebrae in Herrings from the North Western Area and the Dogger Bank etc.

Locality	Date	No. of specimens	Maturity	K_2	Vert. præc.	Investigator
North western Area.						
S. E. of Balta Sound	1—IX—1921	363	III—VII	14.85	23.84	Johansen
Fair Isle	$^{27}/_{29}$—VI—1887	75 (30)	III—VI	14.80	23.63	Heincke
Moray Firth	$^{18}/_{19}$—VII—1906	50	II—IV	14.76	23.74	Redeke
Off Peterhead	VIII—1871	24	IV—VI	14.83	..	Heincke
Off Firth of Forth	8—IX—1904	31	II—III	14.74	23.81	Broch
Dogger Bank etc.						
N. W. of Dogger Bank	19—VIII & 3—IX—1906	40	III—IV	14.90	24.28	Redeke
Dogger Bank	6—IX—1904	31	II—IV	14.84	23.74	Broch
— —	11—X—1906	25	III—VI	15.25	24.04	Redeke
West of Sylt	4—VIII—1889	30	I	14.90	24.36	Heincke

It is not known whether the relatively high number of keeled scales is characteristic to all herrings spawning on the Dogger Bank and in the area between the Dogger Bank and the English coast (comp. Fig. 6) or only to a part of them. There is some evidence to hand that the herrings which have a relatively high number of keeled scales, have usually a higher number of precaudal vertebrae and a lower number of caudal vertebrae than the other Bank Herrings of the North Sea.

There is a possibility that the sample from the Dogger Bank investigated by Broch has contained some specimens belonging to the Channel Sea Herring (specimens of maturity II).

The morphological differences between the Scotch Summer Herring and the Dogger Bank Herring (or a part of those) are indeed very small, but they indicate a certain degree of independence for each

of the groups. Future investigations may show whether the differences are so constant that we can use them as a distinguishing mark between two different races of Bank Herrings.

In connection with the small morphological differences pointed out here, it should be noted that herrings of the same age are larger in the north western part of the North Sea than off the East Coast of England (see Chap. VIII).

The Autumn Herrings of the German Bight have probably a somewhat smaller number of vertebrae than the Bank Herring of the North Sea, as will appear from the survey below:

Number of vertebrae etc. in the Bank Herring of the North Sea and the Autumn Herrings of the German Bight.

A. The Bank Herring of the North Sea.

Locality	Date	No. of spec. examined	Average length cm	Maturity	Vert. S.	Investigator
S. E. of Balta Sound.....	1—IX—1921	363	28.5	III—VII	56.50	Johansen
Fair Isle.....	$^{27}/_{29}$—VI—1887	75	26.4	III—VI	56.45	Heincke
Moray Firth	$^{18}/_{19}$—VII—1906	50	24.7	II—IV	56.56	Redeke
Off Firth of Forth.....	8—IX—1904	31	25.4	II—III	56.45	Broch
N.W. of Dogger Bank	19—VIII & 3—IX—1906	40	25.2	III—IV	56.50	Redeke
Dogger Bank.....	6—IX—1904	31	25.6	II—IV	56.58	Broch
— —	9—IX—1890	5	25.7	V—VI	56.80	Heincke
— —	3—X—1911	106	27.0	III—VI	56.43	Delsman
— —	14—IX—1912	50	27.2	III—VI	56.54	—
— —	11—X—1906	25	26.4	III—VI	56.44	Redeke
[Jutland Bank.....	12—IX—1889	29	28.6	V—VII	56.55	Heincke]

B. The Autumn Herrings of the German Bight.

Locality	Date	No. of spec. examined	Average length	Maturity	Vert. S.	Investigator
S. of Horns Reef.....	13—IX—1890	11	24.9	V—VI	56.45	Heincke
— — —	19—IX—1922	65	..	I	56.32	Johansen
S. W. of Graadeep.....	30—XI—1922	50	..	I	56.40	—
Mouth of Elbe	1877—1891	76	..	I—II	56.34	Heincke
Off Helgoland.....	3—X—1894	25	..	I	56.52	—
N. of Terschelling	4—IX—1890	29	..	I	56.29	—

In connection with the small difference in the number of vertebrae it should be noted that the Autumn Herrings of the German Bight are probably spawning in water of less salinity than the Bank Herring of the North Sea (see Chap. X).

The North Sea Deep Water Herring, which is known from Broch's investigations, has a little higher number of vertebrae (Vert. S.) than the Bank Herring of the North Sea, viz. 56.70 ± 0.05, and a somewhat lower number of keeled scales, about 14.40 to 14.50 in mean value (comp. p. 6). The spawning places for this herring are probably situated on rough grounds on rather deep water on the northern plateau of the North Sea (see Chap. IX and X) where the temperature in the spawning period is somewhat lower than in the area where the Bank Herring is spawning.

VIII. Age and Size of mature Summer- and Autumn-Spawning Herrings from different parts of the North Sea.

Some doubt has been expressed in later years as to the validity of the results arrived at by the new method of age determinations, by means of rings in the scales (D'Arcy W. Thompson & Catherine Sherriff 1922). In my opinion the "ring method" signifies a great progress in comparison with the me-

thods previously used for age determinations, but it is quite clear that the method is far from being exact. Erroneous determinations are probably frequent, and mainly on account of the fact that the winter rings are often not more distinct than the "secondary rings" which have nothing to do with the winter rings. Each naturalist forms here his own praxis in his distinction between the two sorts of rings. He may be able to count the number of "winter rings" approximately in the same way at different times, but this is not a sufficient proof that the counting is correct. There is some evidence at hand that the first winter ring is often feeble or wanting, and in old specimens it is usually the case that there is an outer zone with more or less indistinct rings which are lying very close to eachother. In this zone the distinction between winter rings and secondary rings becomes highly arbitrary.

It is beyond the purpose of this paper to give a general view of the age determinations hitherto carried out of the autumn herrings of the North Sea. I shall here represent only the results of the age determinations of the samples of Shetland Herrings and Bohuslän Herrings[1] examined by me and my collaborators (see Tables 1, 2 and 4), and for the sake of comparison I shall state the result of some of the age determinations of mature autumn spawning herrings from other parts of the North Sea investigated by Hjort & Lea (1910) and by Storrow & Dorothy Cowan (1920).

This comparison (Table 3) shows, that herrings with the same number of winter rings (4—9) were practically of the same average length at Balta Sound and at Peterhead. On the other hand the autumn herring on the stretch from North Shields to Haighsborough Float are, on an average, 1—2 cm shorter at the same age than the herrings from the Shetland Isles and Peterhead, and finally, the Bohuslän Herring has on an average the same size as herrings of the same age from North Shields to Haighsborough Float.

Dorothy Cowan has found previously that herrings in the northern parts of the North Sea are larger at the same age than herrings from the more southernly fishing grounds off the English east-coast.

Table 1. Age and Length of mature Herrings caught S. E. of Balta Sound on Sept. 1. 1921.
(Age indicated by number of winter rings in the scales).

Length cm.		25	26	27	28	29	30	31	Total no. of specimens	Average length cm	Corrected by 0.5
Year class	No. of winter rings										
1917	3	..	1	..	..	..	..	..	1	26.0	26.5
1916	4	..	2	8	9	2	2	..	23	27.74	28.24
1915	5	1	9	20	24	13	2	..	69	27.65	28.15
1914	6	..	3	18	20	13	3	1	58	27.97	28.47
1913	7	1	6	18	22	23	5	1	76	28.04	28.54
1912	8	..	1	3	22	16	9	3	54	28.70	29.20
1911	9	..	..	2	10	4	5	1	22	28.68	29.18
1910	10	..	..	..	1	3	1	..	5	29.0	29.5
1909	11	..	..	..	..	..	1	..	1	30.0	30.5
..	3—4	..	..	1	..	..	..	..	1	27.0	27.5
..	4—5	..	..	..	1	..	..	1	2	29.5	30.0
..	5—6	..	..	1	6	1	..	..	8	28.0	28.5
..	6—7	..	..	1	4	1	1	..	7	28.29	28.79
..	6—9	..	..	..	..	..	1	..	1	30.0	30.5
..	7—8	..	..	..	1	1	1	1	4	29.5	30.0
..	8—9	..	..	..	1	1	2	..	4	29.25	29.75
..	8—12	..	..	..	1	..	..	..	1	28.0	28.5
..	9—10	..	..	..	..	2	1	..	3	29.33	29.83
..	?	..	3	5	11	2	1	1	23	27.83	28.33
Total number of spec. .		2	25	77	133	82	35	9	363	..	..

[1] See also p. 72—73.

Table 2. Age and Length of Herrings of Maturity VIII caught in purse seine N. W. of Hirshals. March 6. 1923.

Length cm		20	21	22	23	24	25	26	27	28	29	Total no. of spec.	Average length cm	Corrected by 0.5
Year class	No. of winter rings													
1919	3	..	2	2	5	2	1	1	1	..	..	14	23.36	23.86
1918	4	2	4	14	8	7	4	1	..	1	..	41	22.88	23.38
1917	5	..	2	3	7	6	8	7	2	..	..	35	24.26	24.76
1916	6	..	..	..	2	1	1	6	4	..	1	15	25.87	26.37
1915	7	..	..	..	..	..	..	1	..	..	..	1	26.00	26.50
1914	8	..	..	..	..	..	..	..	2	..	1	3	27.67	28.17
1913	9	..	..	..	..	..	..	..	..	..	..	..	..	..
1912	10	..	..	..	..	..	..	..	..	..	..	..	..	..
1911	11	..	..	..	..	..	..	..	..	1	..	1	28.00	28.50
..	4—5	..	..	1	..	2	..	..	..	..	..	3	23.33	23.83
..	4—6	..	..	..	..	..	..	..	..	1	..	1	28.00	28.50
..	4+	..	..	..	..	..	1	..	..	..	..	1	25.00	25.50
..	4?	..	1	..	..	1	..	..	1	..	..	3	24.00	24.50
..	6?	..	..	..	..	..	..	2	..	..	..	2	26.00	26.50
Total no. of specimens .		2	9	20	22	19	15	18	10	3	2	120	..	..

Table 3. Age and Average Length of mature Autumn Herrings from various parts of the North Sea.

Locality	20 miles S. E. of Balta Sound (Johansen & Poulsen)	14 miles E. of Peterhead (Storrow & Cowan)	Off North Shields (Hjort & Lea)	10 miles E. N. E. of Scarborough (Storrow & Cowan)	[Grimsby] (Hjort & Lea)	3 miles N. of North Haisborough Float (Storrow & Cowan)	N. W. of Hirshals (Johansen & Poulsen)	3 miles N. W. of Skagen (Johansen & Bruun)
Date	1—9—1921	9—9—1919	22—10—1909	29—9—1919	30—9—1909	20—11—1919	6—3—1923	5—1—1924
State of Maturity ...	III—VII	IV—VII	IV—VII	IV—VII	V—VII	III—VII	VIII	VII—VIII
No. of winter rings	Average length cm							
2	..	25.0	23.0	23.32	23.3	23.42	..	..
3	26.5	26.61	26.9	25.55	24.1	24.33	23.86	23.87
4	28.24	27.47	26.3	26.48	25.0	25.57	23.38	25.34
5	28.15	28.41	26.6	26.98	26.1	26.37	24.76	26.47
6	28.47	29.19	26.8	27.74	26.7	27.08	26.37	27.65
7	28.54	29.25	26.8	28.09	26.9	27.34	26.50	26.50
8	29.20	29.67	27.2	28.50	27.8	28.0	28.17	29.00
9	29.18	29.80	27.2	28.50	27.0	28.67	..	28.50
10	29.5	30.30	27.7	..	25.7	28.67	..	..
11	30.5	30.5	28.0	27.0	..	..	28.50	..
12	..	31.0	..	..	..	..	..	..
No. of winter rings	Number of specimens							
2	..	3	1	19	16	12	..	..
3	1	31	7	42	141	85	14	27
4	23	38	6	60	206	30	41	31
5	69	17	24	56	67	60	35	31
6	58	27	13	19	25	48	15	13
7	76	12	13	32	9	32	1	2
8	54	18	12	12	6	10	3	2
9	22	5	11	4	9	6	..	1
10	5	3	12	..	3	3	..	..
11	1	2	3	1	..	..	1	..
12	..	1	..	..	..	..	..	..
Total no. of spec....	309	157	102	245	482	286	110	107

Table 4. Age and Length of Herrings of Maturity VII—VIII caught in purse seine 3 miles N. W. of Skagen. January 5. 1924.

Length cm.		20	21	22	23	24	25	26	27	28	29	Total No. of specimens	Average length cm.	Corrected by 0.5
Year class	No. of winter rings													
1920.....	3	2	2	5	7	5	2	1	2	1	..	27	23.37	23.87
1919.....	4	..	..	1	7	6	5	6	6	..	..	31	24.84	25.34
1918.....	5	..	..	..	3	2	8	5	8	3	2	31	25.97	26.47
1917.....	6	..	..	..	..	..	2	1	5	3	2	13	27.15	27.65
1916.....	7	..	..	..	..	..	..	2	..	..	..	2	26.0	26.5
1915.....	8	..	..	..	..	..	..	..	..	1	1	2	28.5	29.0
1914.....	9	..	..	..	..	..	..	..	..	1	..	1	28.0	28.5
Total no. of specimens		2	2	6	17	13	17	15	21	9	5	107	..	..

IX. On the positions of the Spawning Grounds of the Summer- and Autumn-Spawning Herrings of the North Sea.

We are still far from knowing the extent and location of the main spawning grounds of the summer and autumn spawning herrings of the North Sea, but a series of new facts throwing light upon this difficult problem, has been brought forth in the last decennaries, and it will be worth while to consider, how far our present knowledge extends.

Fulton has, in his important work on "The Chief Fishing Grounds on the East Coast of Scotland" (1891) given detailed information about the situation of the spawning places both as regards winter (or spring) spawners and summer spawners. Very little is stated about the way in which the spawning places have been located, but it seems probable that Fulton for the preparation of his charts has collected all the material then available concerning:

1) actual finds of the herring spawn on the sea bottom.
2) observations about the occurrence of newly hatched herring larvae.
3) observations about the localities where fishes with herring spawn in the stomach have been caught.
4) observations about the places where great quantities of ripe herrings (of maturity VI) are caught.

The position of the spawning places for the summer spawning herring on the stretch from the Shetland Isles to Northumberland, as located by Fulton, is represented in this paper on Fig. 8 p. 41. The spawning places are almost all situated at depths from about 25 to 80 meters.

The charts of Fulton are, of course, of a provisional nature.

From a consideration of the state of maturity of the herrings in different catches taken east of the Shetland Isles, Bjerkan (1917) draws the conclusion that spawning takes place on the slopes of Unst Bank and south of a line drawn between this Bank and Viking Bank, including Bressay Shoals. If this conclusion is right it would seem that spawning takes place here at depths from 80 to 120 meters or even more.

Russell (1914) draws attention to the fact that during the autumn fishing off the coast of Northumberland considerable quantities of haddock are caught whose stomachs are crammed with herring spawn. Some records of the place of capture of such "spawny" haddocks have been collected at North Shields during 1911. The places of capture were situated off the English coast between 55° 30′ and 56° 0′ N. lat., and it appears that they occurred not far from the spawning places located by Fulton. Four of the catches were taken at depths of about 60 meters, 15 catches came from depths between 60 and 80 meters, and 4

catches from depths between 80 and 90 meters. The landings occurred between August 8th and September 26th 1911.

MEEK records (1919) that the summer herring in 1918 was spawning North of the Farnes off the Northumberland coast.

WOOD (1922) tried to locate the spawning grounds east of Scotland and the Shetland Isles by recording the localities of occurrence of shoals of ripe herrings. He finds in this way that spawning places were situated near Out Sherries, east and southeast of Sumburgh Head, on the Fair Bank, east of Lewis, and on several places near the east coast of Scotland, where they were known from previous investigations by FULTON, MITCHELL, etc. WOOD was aware that an accurate determination of the spawning grounds can not be reached by a study of the state of maturity of the herrings in the catches, and he summarises his experiences in the following manner: "Although fish full of milt and roe may be found at least 100 miles from land, as may be seen in samples of trawled herring, it is fairly obvious that the most favoured areas lie close to or within the immediate coastal zone".

WOOD gives also some information about the occurrence of "spawny" haddocks in the Scotch waters in the summer of 1922, but this subject is more fully dealt with by A. BOWMAN (1923), who gives a series of valuable records regarding date and locality for catches of "spawny" haddocks in spring and summer of the two years 1921 and 1922. Among the interesting results arrived at by BOWMAN the following should be quoted: "In the first place, it is obvious from the accompanying chart that the spawning grounds chosen by the herring for the two years in question were approximately the same, the variations on the whole not suggesting any considerable change from one year to another in the localities chosen..."

"In the second place, the chart shows that the greater number of 'spawny' haddocks caught by trawlers in spring come from grounds to the north-west of Scotland, extending from the Butt of Lewis to Muckle Flugga, whilst the greater number of catches in autumn come from the East Coast of Scotland..."

"The third point brought out by the data is that, although the spawning grounds extend over considerable areas, the distribution of the spawn itself does not appear to be uniform, but occurs rather in more or less extensive patches..."

"The fourth and probably the most interesting point elucidated is that spring and autumn spawning may take place on approximately the same grounds.... The selection of the same grounds by spring and autumn spawners suggests that two of the most potent factors determinating the positions of the herring spawning grounds are depth and nature of bottom".

"Finally, the data suggest that, at least on the more extensive spawning grounds both during summer and winter successive waves of spawning shoals visit the spawning grounds to deposit their eggs, and that haddock drawn from the surrounding area segregate on these grounds in turn throughout the incubation periods".

The localities from which "spawny" haddocks have been recorded by BOWMAN in August, September and October 1921 and 1922 are represented on Fig. 7 p. 40 without keeping the two years apart.

From the Dutch investigations of BOEKE (1906), REDEKE and VAN BREEMEN (1907—1908), it is quite clear that spawning places for autumn herrings occur on the Dogger Bank itself and in the area off the east coast of England between 53° and 55° N. lat. REDEKE found that almost all haddock in a sample caught north of the South West Patch of the Dogger in October 1904 contained herring eggs, and at many of the Dutch seasonal stations newly hatched herring larvae were found. It will here be worth while to recall the localities where such small herring larvae were found.

The positions of the Dutch Seasonal Stations were as follows:

H 1	N. W. of Texel	53° 14′ N. 4° 15′ E. ca. 30 m
H 2	S. of Cleaver Bank	53° 45′ N. 3° 27′ E. - 40 -
H 3	S. of Dogger Bank	54° 06′ N. 2° 55′ E. - 40 -

H 4	Dogger Bank	54° 33′ N. 2° 05′ E.	ca. 20 m
H 5	W. of Dogger Bank	54° 06′ N. 1° 26′ E.	- 50—70 m
H 6	Off Spurn	53° 40′ N. 0° 32′ E.	- 25 m
H 7	N. W. of Cromer	53° 06′ N. 1° 11′ E.	- 20 -
H 8	Deep Water Channel	52° 40′ N. 2° 28′ E.	- 40—50 m
H 8 A	— — —	52° 30′ N. 3° 00′ E.	- 40 m
H 9	E. of Deep Water Channel	52° 15′ N. 3° 28′ E.	- 30 -

On the Dutch seasonal cruise in November 1902 some herring larvae were taken at the surface with plankton net at St. H 6. On the cruise in November 1903 no herring larvae were observed, but in November 1904 great masses of larvae were caught at several stations, and mainly at H 3, H 5, H 6 and H 7. At the two last stations the Hensen Net was used for vertical hauls, and at H 6 were taken 43 larvae (of 8—17 mm length) pr. m^2, and at H 9 13 larvae (of 9—10 mm length) pr. m^2. At station H 8 no larvae were taken by the Hensen Net and only a single larva with the Helgoland Young Fish Trawl (Scherbrutnetz), and at St. H 1, H 8 a, and H 9 no larvae were captured either with Hensen Net or with Young Fish Trawl.

On the Dutch seasonal cruise in November 1906 numerous herring larvae were taken with young fish trawl and egg nets on the Stations H 3, H 4, and H 7, and at all these stations newly hatched larvae of less than 10 mm length occurred. Newly hatched larvae were also taken on St. H 2 and St. H 8, but the number caught here was much smaller. At St. H 4 several larvae of 11—20 mm length were taken. At St. H 8 a and H 9 no herring larvae occurred.

Having regard to the direction of the prevalent currents I consider it probable that the numerous young herring larvae from St. H 3 taken in November 1904 and 1906 originate from spawning places on the south western part of the Dogger Bank. The larvae taken at H 6 and H 7 come without doubt from spawning places situated between the Dogger Bank and the English coast.

Redeke and van Breemen are of opinion that the few herring larvae caught at the Dutch Stations south of 53° N. lat. in November originate from spawning grounds situated between the Dogger Bank and the English coast and not from herrings which have spawned in the actual area where the larvae have been taken. They lay stress upon the fact that the herring of the Deep Water Channel is a winter spawning herring, and they believe that the spawning places for this herring are situated near the entrance of the English Channel.

Hjort (1905) gives much valuable information about time and place for the catches of full herrings and spent herrings in various parts of the North Sea. It appears from Hjort's observations that almost all herrings caught in November in the important herring fishing area between 52 and 53° N. lat. and 2 and 3° E. long. are full herrings and only very few spent herrings.

Borley and Russell state (1922) that spawn of herring was taken on the Inner Trawling Ground (West of Dogger Bank) in September 1913, but a more exact location is not given.

The same authors are of opinion that a great spawning ground probably occurs in the neighbourhood of Smith's Knoll. They write about this question as follows (p. 48): "In view of the enormous concentration of the herring off the Norfolk coast in the region of Smith's Knoll in the later part of the season, the existence of a great spawning ground in the vicinity can hardly be doubted. There is, however, no direct information on this point".

The herrings which are caught in great quantities in the region of Smith's Knoll in October—November are mainly winter spawners (see Chap. XI), but as no great herring fishing takes place in this region at the time when these herrings are spawning (about December—January), it seems doubtfull whether Borley and Russell are right in their view.

Very little has been published about the situation of the spawning places in the eastern part of the North Sea.

Duge (1903) and Ehrenbaum (1904) state that the stomach of the haddock and the frogfish captured on the Little Fisher Bank and the Jutland Bank from September 30. till October 4. 1903 contained herring eggs. Duge (1903) writes as follows about this observation:

"In der Zeit vom 30. September bis 4. Oktober 1903 fischten die Fischdampfer Eva, Kapitän Külper und Jade, Kapitän M. Modersitzki aus Geestemünde auf der Kleinen Fischerbank auf etwa 57° N-Breite

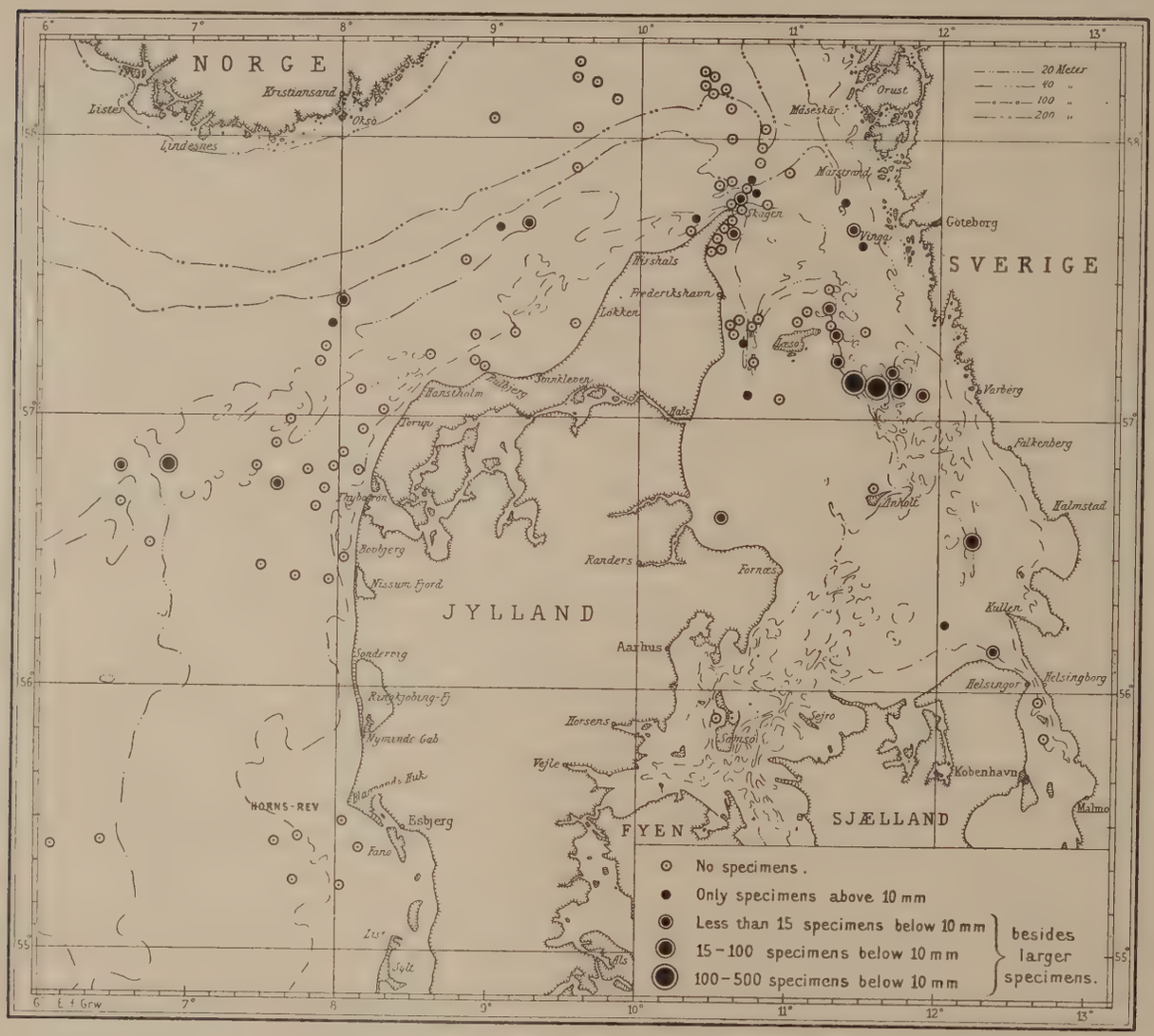

Fig. 1. Catch of herring larvae per 30 minutes haul with Petersen's Young Fish Trawl in September—November 1903—06 and September—October 1922.

und 7° O-Länge, wo sie einen recht guten Fang an grossen und mittel Schellfischen erzielten. Beim Ausweiden der Fische fiel es auf, dass ihre Magen stark und theilweise zum Platzen gefüllt waren. Der Inhalt bestand aus kleinen Fischeiern. Alle in dieser Gegend gefangenen Fische und auch die auf der Jütlandbank angetroffenen hatten ausschliesslich solche Eier im Magen. Auffällig war ferner die grosse Menge todter Fische, die mit dem Netz heraufgebracht wurde. Ausser ganz frischen, offenbar eben eingegangenen

Fischen, die noch ganz klare Augen hatten, kamen zentnerweise Fische vor, die schon länger todt waren. Unter den todten Fischen waren Seeteufel (Lophius) ziemlich häufig, die ebenfalls den Magen voller Rogen hatten. An einigen Stellen, nahe dem steinigen Grunde, kamen grosse Mengen Fischeier mit dem Netze herauf, die sich in den Maschen festgesetzt hatten.

Den Fischern war diese Erscheinung sehr auffällig, da es sich um ganz enorme Mengen von Fischeiern handelte, die nach dem Inhalt der Magen und den im Netze haftenden Quantitäten am Grunde vorhanden

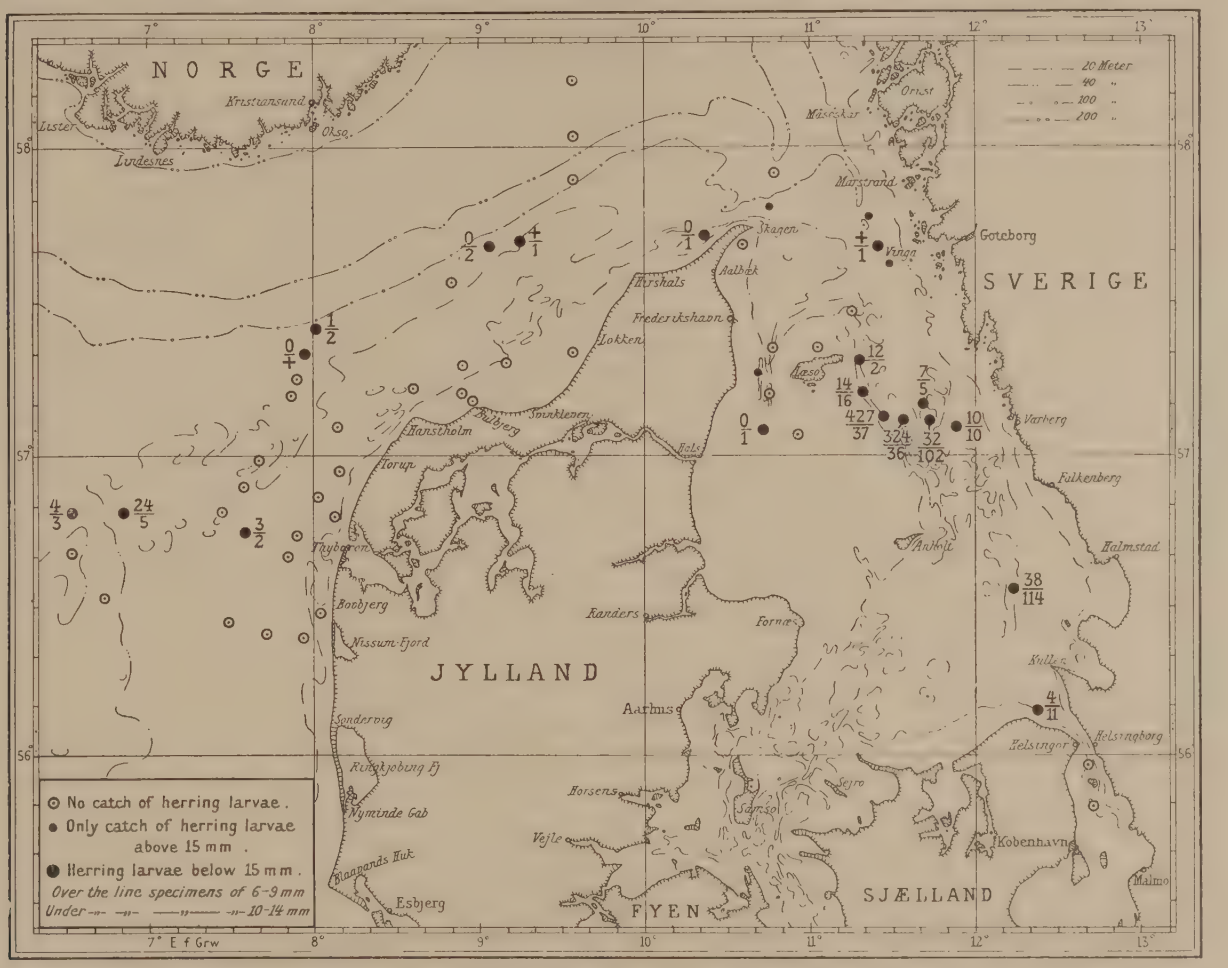

Fig. 2. Catch of herring larvae per 30 minutes haul with Petersen's Young Fish Trawl in September—October 1922.

sein mussten und da sie annahmen, die Fische hätten soviel Eier gefressen, dass sie eingegangen seien, bezw. wie behauptet wurde, dass ihr Magen geplatzt sei".

A series of new facts is, however, to hand concerning herring larvae caught in the Danish fishing experiments with Young Fish Trawl and Plankton Nets in the North Sea and the Skagerak in the years 1903—07 and 1922—24.

In Figs. 1 and 2 the catches of herring larvae taken by the Danish research steamer with Petersen's Young Fish Trawl[1]) during the autumn season have been represented. In Fig. 1 the catch is represented graphically, and the Chart comprises stations from the years 1903—06 and 1922. In Fig. 2

[1]) The opening of Petersen's Young Fish Trawl in front was 2—2.5 m × 1.3 m. In some cases a ring trawl of stramin of 2 m in diameter was used.

the number of herring larvae taken in September—October 1922 is put down with statements about number of larvae of different size.

Fig. 3 illustrates the number of larvae taken with vertical hauls with Hensen Net per m².

It appears from these charts that no herring larvae have been caught in the Horns Reef area (between 55 and 56° N. and east of 6° E.) during the Danish fishing experiments with young fish

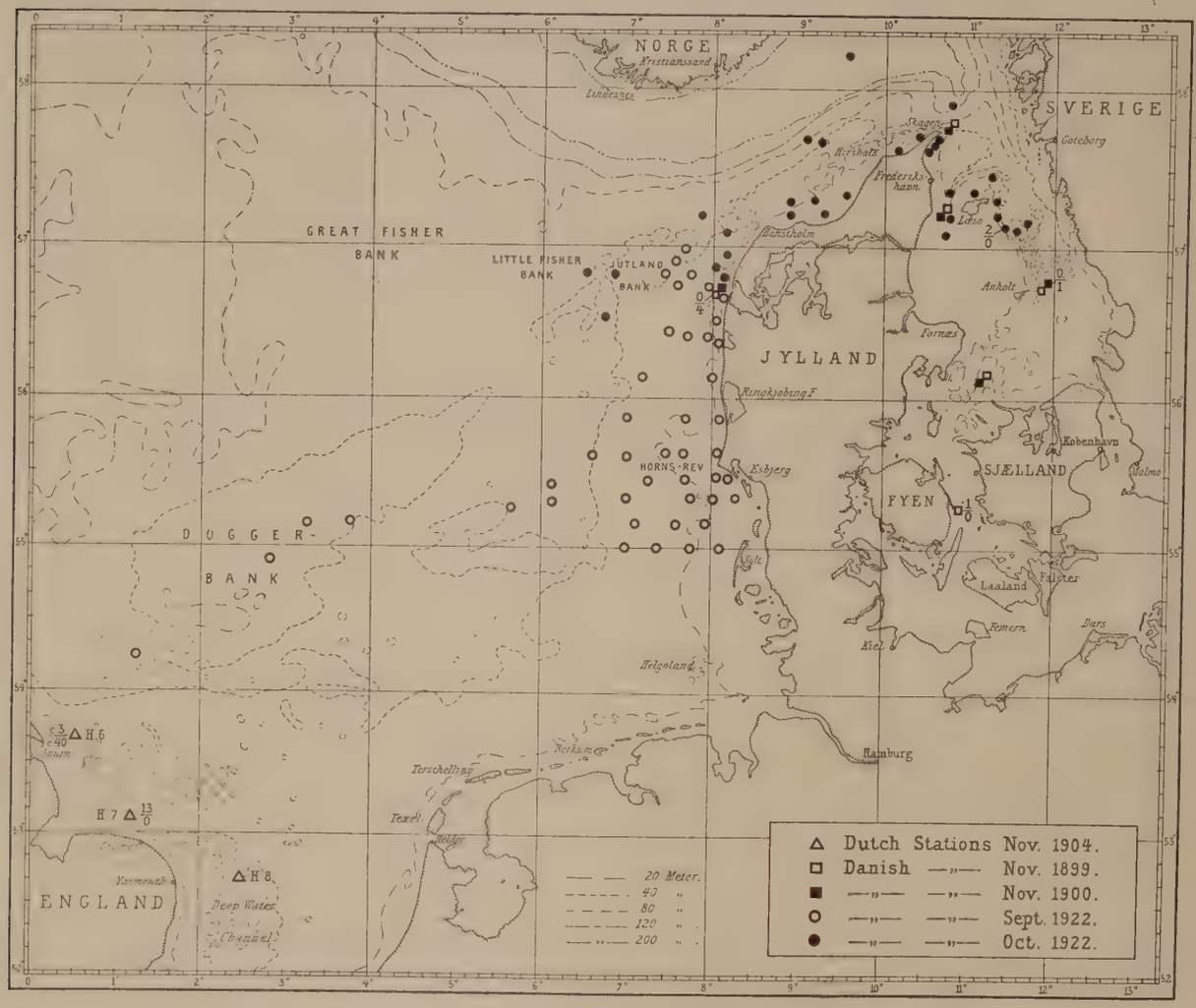

Fig. 3. Catch of herring larvae with vertical hauls by Hensen Net, per m².
Over the line: number of larvae of less than 10 mm length.
Below the line: number of larvae of 10—17 mm length.
If no figures at the stations, no larvae were caught.
The Danish records from 1899 and 1900 originates from C. G. Joh. Petersen (1903).

trawl and Hensen Net during the autumn. Experiments with Hensen Net were undertaken in September 1922 (13 Stations). Experiments with Young Fish Trawl were carried out in September 1903 (1 Station), and in September 1904 (7 Stations).

Later experiments with Young Fish Trawl in the waters close west of Graadeep have given negative results during the following months:

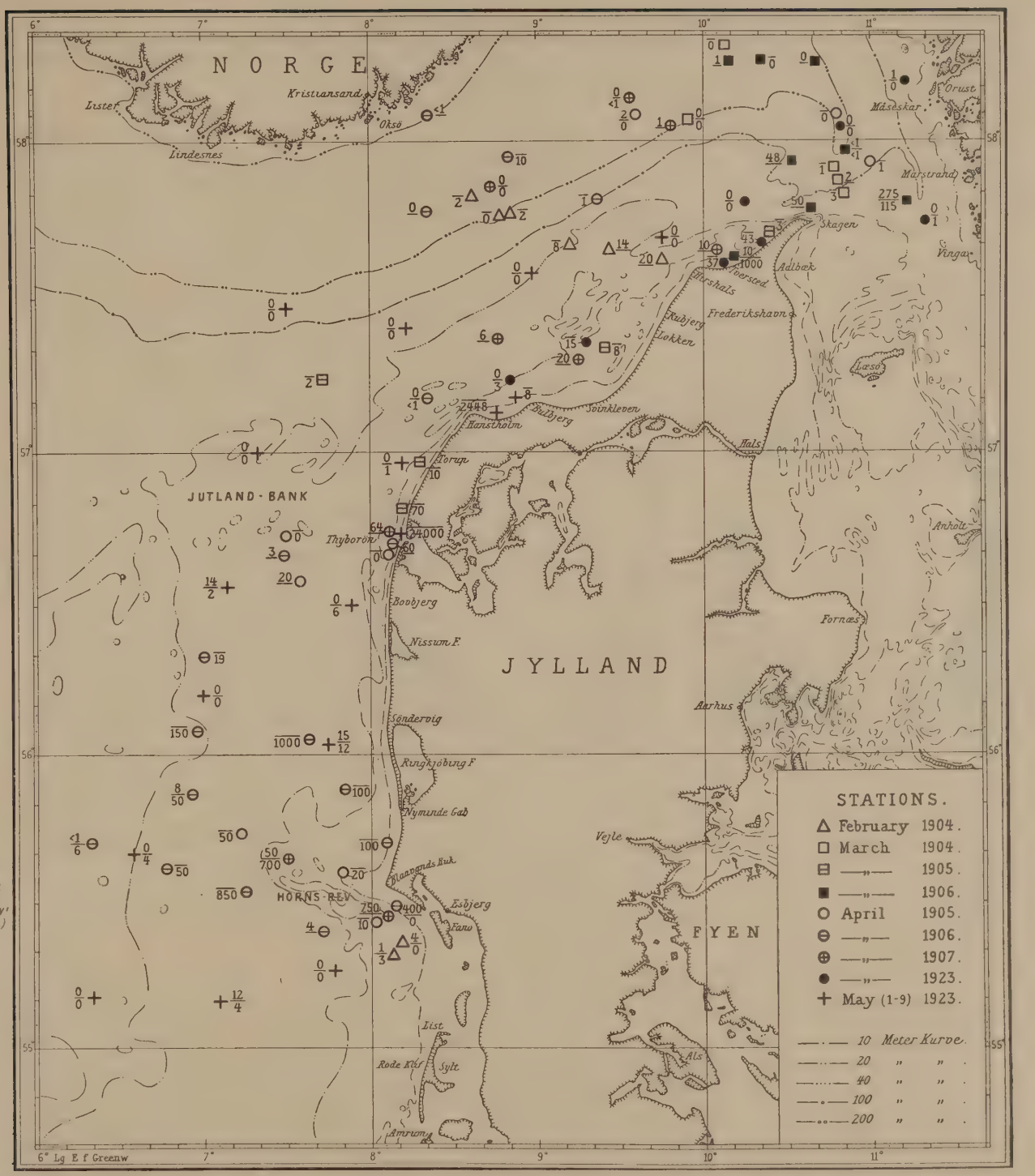

Fig. 4. No. of herring larvae of autumn spawners caught in the spring months per 30 minutes during the Danish fishing experiments by Petersen's Young Fish Trawl.
Over the line: number of specimens caught in the upper layers.
Below the line: number of specimens caught in the lower layers.

November 1922 (2 Stations)
December — (1 Station)
January 1923 (1 Station)
— 1924 (2 Stations)

From these experiments we gain the impression that if spawning places for an autumn herring occur in the Horns Reef Area or adjacent parts of the German Bight, they must be of very little importance.

In February of 1904 a few herring larvae of 24—41 mm length were caught with Young Fish Trawl south of Horns Reef, and in April of the years 1904, 1905, 1906, 1907 and 1923 several larvae of 13—45 mm length were taken in the Horns Reef Area. These large larvae may have come from the southern part of the German Bight or even from more distant areas.

In the area around the Little Fisher Bank and the Jutland Bank some newly hatched larvae were taken with Young Fish Trawl at the end of September and the beginning of October 1922, (Fig. 1, 2 and Tables 5 and 6), but most of the stations gave negative catches, and the same was the case with a few stations taken in October 1904. In vertical hauls with Hensen Net a few larvae of 15—16 mm length were taken off Thyborön in November 1899 and December 1900 (Petersen 1903). A coast herring is spawning in autumn (September—November) in the western part of the Lim Fiord, and we do not know whether the larvae taken off Thyborön originate from this herring or from the Jutland Bank Herring.

February. August.

Fig. 5. View of the mean surface currents of the North Sea. After Böhneche. 1922.

In the south western Skagerak a few herring larvae have been caught in autumn. Two larvae of 9—11 mm and 6 larvae of 14—15 mm length were taken N. W. of Rubjerg Knude Light on October 4, 1922, and 8 larvae of 11—17 mm length were taken at about the same place on October 14. 1922 (see Tables 5 and 6). It is probable that spawning places occur here and there in the south western Skagerak, but there is no evidence that these spawning places are of much importance.

Altogether we gain the impression that the spawning places situated in the area of the Little Fisher Bank and the Jutland Bank are usually not of very great importance.

From Fig. 4 it will be seen that many very large catches of larvae of autumn spawners have been taken off the west coast of Jutland in the spring months.

As all the large catches of larvae of autumn spawners have been taken in the spring months and none in autumn, it seems probable that most of the larvae occurring in the spring months at the west coast of Jutland have been transported by the currents from the Dogger Bank or the East Anglian Area. In this connection it should be remembered that the analysis of a large sample of young herrings, originating from autumn spawners, and taken at Thyborön on the 16. July, 1918, showed the same racial characteristics as the Dogger Bank Herring (comp. p. 16—17).

If we regard the situation of the spawning grounds in the western part of the North Sea between 53° and 55° N. (see Fig. 6) and the direction of the prevalent currents (Fig. 5) we should expect that

greater quantities of herring larvae should be caught off the northern coasts of Jutland than in the Horns Reef Area. If we look at the chart Fig. 4, we notice, however, that more larvae have usually been taken in the Horns Reef Area than off the more northern parts of Jutland. This fact seems to show that the active migrations of the herring larvae plays a great rôle when they have reached a certain length.

Great shoals of young herrings occur often at the western entrance to the Lim Fiord, and it will be noted that a very large catch of larvae has been taken there.

From Fig. 4 it will be seen that almost all the great catches of larvae of autumn spawners are taken in the coastal areas in the spring months. This fact harmonizes with the view of A. T. Masterman (1896): that the older stages of the herring larvae and the youngest stages of the herring after the transformation occur mostly in the litoral Zone[1]).

It will be seen from Fig. 1 and Fig. 2 that many young herring larvae have been taken in the eastern Kattegat in autumn, but these larvae originate from spawning places actually in the Kattegat, and the herrings spawning there are different in their racial stamp from those spawning in the North Sea (see Chap. XI). In the neighbourhood of Skagen a few young herring larvae have been caught. It is not known whether these have come from the Skagerak or from the spawning places of the northern Kattegat. During the autumn of 1899 and of 1900 a series of vertical hauls with Hensen Net were taken from the light vessel of Skagen in such periods when the current was coming from West, but no larvae were caught in such hauls (C. G. Joh. Petersen, 1903).

If we look at the chart Fig. 3 it is a striking feature that very few larvae have been taken in the Danish waters in comparison with those taken at the Dutch Stations H 6 and H 7 off the East Coast of England. The greatest catches per m^2 in the Danish waters are 4 and 2, but on the two named Dutch Stations, 43 and 13 larvae were caught respectively.

In Table 6 the size of the larvae taken in the Jutland Bank Area in September and October 1922 is represented. It will be seen that most of the larvae taken between September 28. and October 2. were very small. They were probably hatched in the last half of September. Their average length was only 9.4 mm, while the average length of the specimens taken on the 14. and 15. October was 14.5 mm. This may indicate a growth of about 5 mm in the first half of October. It appears from Table 7 that the growth in the winter months must be much slower, about 4 to 5 mm per month. In the period from March 21. to May 4. the increase in length may be estimated to be about 13 mm or about 9 mm per month.

Table 5. List of Stations where Herring Larvae were caught in the Jutland Bank Area including the Southern Skagerak North of Jutland. Sept. Oct. 1922.

Fishing experiments from the "Dana" with Petersen's Young Fish Trawl.

Station No.	Date	Place	Central Position		Depth in m	Temperature		Salinity		Depth of fishing	Duration of fishing		No. of Larvae caught
			N. Lat.	E. Long		Surface	Bottom	Surface	Bottom		Hours	Min.	
	1922												
2839	Sept. 28	17 miles W. ¾ N. of Lodbjerg Light ...	56°49′	7°45′	36	12.0	12.3	33.7	34.5	Near bottom	..	30	12
2843	— 29	22 miles W. of Lodbjerg Light	56°45′	7°36′	41	12.4	12.5	34.1	34.5	Near bottom 85 m wire	..	30	5
2852	Oct. 1	55 miles NW. by W. ½ W. of Bovbjerg L.	56°49′	6°32′	48	12.6	10.6	34.5	34.7	Near bottom 80 m wire	..	30	7
2853	— 1	45 miles W. by N. of Lodbjerg Light...	56°49′	6°51′	34	12.8	11.8	34.8	35.0	Near bottom 75 m wire	..	30	29
2861	— 2	NW. of Hanstholm	57°25′	8°01′	80	..	..	..	..	Intermediate 130 m wire	2	..	14
2862	— 3	26 miles NW. ¼ W. of Hanstholm.....	57°20′	7°57′	60	..	..	..	..	Intermediate 70 m wire	2	..	1
2869	— 4	22 miles NW. ½ N.of Rubjerg Knude Light	57°42′	9°15′	47	11.8	12.0	34.3	34.8	Near bottom 100 m wire	2	..	8
2892	— 11	2.5 miles NE. by N.of Skagen Light-Vessel	57°48′.5	10°45′.5	90	10.2	8.2	24.6	35.2	Near bottom 250 m wire	..	30	1
2906	— 14	26 miles NW. ¼ W.of Rubjerg Knude Light	57°41′	9°04′	70	10.82	9.0	32.09	34.97	Intermediate	4	..	8
2912	— 15	5.5 miles W. ½ S. of Højen Light	57°43′	10°22′	25	10.8	11.2	..	..	Near bottom	..	30	5

[1] Masterman (1896 p. 295) writes as follows about this matter: "By a length of some 20—25 millimetres, the young herrings have reached the surface water, or are near the surface, and they then migrate shorewards, taking up a littoral habit, commonly at the mouths of rivers, where they usually move about in small shoals."

Table 6. Lengths of Herring Larvae caught in the Jutland Bank Area including the Southern Skagerak North of Jutland in September—October 1922.

Fishing experiments from the "Dana" with Petersen's Young Fish Trawl.

Month	September		October							
Date	28.	29.	1.	1.	2.	3.	4.	11.	14.	15.
Year	1922	1922	1922	1922	1922	1922	1922	1922	1922	1922
Station No.	2839	2843	2852	2853	2861	2862	2869	2892	2906	2912
Length mm.										
6	..	..	..	..	..	..	..	..	..	..
7	3	..	..	2	..	..	..	..	..	..
8	4	1	2	7	..	..	..	..	..	..
9	3	2	2	15	3	..	1	..	..	..
10	1	2	3	4	5	..	..	..	..	..
11	..	..	..	1	1	..	1	..	1	..
12	1	..	..	..	..	..	..	..	1	..
13	..	..	..	..	2	1	..	..	2	..
14	..	..	..	..	1	..	4	..	3	1
15	..	..	..	..	1	..	2	..	..	1
16	..	..	..	..	1	..	..	..	..	1
17	..	..	..	..	..	..	..	..	1	1
18	..	..	..	..	..	..	..	..	..	..
19	..	..	..	..	..	..	..	1	..	1
20	..	..	..	..	..	..	..	..	..	..
	12	5	7	29	14	1	8	1	8	5

We can now summarise the results arrived at concerning the extent and location of the spawning places for the summer and autumn spawning herrings of the North Sea in the following way:

The main spawning places are situated near the British coasts, from the Shetland Isles to Norfolk, at depths from about 20 to about 90 meters, including the Dogger Bank. Spawning places of some importance are situated on the Little Fisher Bank and the Jutland Bank, including the adjacent parts of the Skagerak. The Herrings spawning on these grounds seem to belong to one single race: the Bank Herring of the North Sea (see Chap. VII).

Spawning grounds are also situated here and there far from the shore on the banks of the northern plateau of the North Sea at depths from about 70 to 120 meters, or even more. The racial characteristics of the herrings spawning there are but little known, but according to the results of investigations carried out by Broch, it must be supposed that these herrings belong to another race than the Bank Herring, viz.: The North Sea Deep Water Herring (see Chap. VII).

The position of the spawning places of the Autumn Herrings of the German Bight is not known as yet. They are usually of very little importance.

X. On the Temperature and Salinity at the spawning places of the Summer- and Autumn-Spawning Herrings of the North Sea.

After Bulletin Trimestriel 1906—07, Partie Supplementaire, the maximum temperature for the year at the sea bottom is represented on the chart Fig. 6, p. 39, and on the same chart the approximate situation of the spawning places of the summer- and autumn-spawning herrings is shown according to the information referred to in Chap. IX. It appears from this chart that most of the spawning places occur

Table 7. Lengths of Herring Larvae[1]) caught in various months from September to May in the Jutland Bank Area.
Danish Fishing Experiments with Petersen's Young Fish Trawl.

Month Date Year	September 28.—29. 1922	October 1.—15. 1922	November 14.—19. 1903	February 17. 1904	March 11.—30. 1903, 1904 1906	April 30. 1923	May 1.—9. 1923	
Length mm.								Length mm.
7	3	2	..	..	..	..	..	7
8	5	9	1	..	1	..	..	8
9	5	21	2	..	..	1	..	9
10	3	12	1	..	..	27	..	10
11	..	4	..	..	..	60	1	11
12	1	1	..	1	..	75	3	12
13	..	5	..	..	..	57	2	13
14	..	9	..	..	..	25	2	14
15	..	4	..	1	..	10	5	15
16	..	2	..	..	..	9	6	16
17	..	2	..	..	..	3	8	17
18	..	..	3	1	1	4	1	18
19	..	1	..	1	..	2	3	19
20	..	..	1	1	..	..	..	20
21	..	..	..	1	..	..	1	21
22	..	..	..	..	..	..	2	22
23	..	..	..	4	2	..	..	23
24	..	..	..	..	2	..	3	24
25	..	..	..	1	..	..	..	25
26	..	..	..	4	1	1	3	26
27	..	..	..	1	..	1	2	27
28	..	..	..	2	2	..	4	28
29	..	..	..	1	..	1	3	29
30	..	..	..	..	2	2	4	30
31	..	..	..	2	..	1	3	31
32	..	..	..	1	..	3	3	32
33	..	..	..	1	2	1	5	33
34	..	..	..	..	..	4	4	34
35	..	..	..	..	1	3	3	35
36	..	..	..	..	..	3	6	36
37	..	..	..	..	2	5	6	37
38	..	..	..	..	1	1	10	38
39	..	..	..	..	..	2	30	39
40	..	..	..	..	1	..	52	40
41	..	..	..	..	..	2	61	41
42	..	..	..	..	..	9	68	42
43	..	..	..	..	..	7	68	43
44	..	..	..	..	..	8	67	44
45	..	..	..	..	..	13	69	45
46	..	..	..	..	..	12	59	46
47	..	..	..	..	..	5	48	47
48	..	..	..	..	..	2	35	48
49	..	..	..	..	..	2	15	49
50	..	..	..	..	..	4	7	50
51	..	..	..	..	..	3	5	51
52	..	..	..	..	..	1	1	52
53	..	..	..	..	..	2	..	53
No. of larvae of autumn herrings.	17	72	8	23	17	98	ca. 644	
Aver. length mm.	8.7	10.9	13.75	23.7	29.8	42.3	42.8	
No. of larvae of spring herrings	..	..	..	..	1	273	ca. 34	

[1] The largest specimens taken between April 30. and May 9. were in the transitional stage, but none of these were covered by scales.

Table 8. List of Stations where Herring Larvae of Autumn-Spawners were caught off the West Coast of Jutland and in the Southern Skagerak in the spring months 1904—07 and 1923.

(Petersen's Young Fish Trawl).

Station No.	Date	Locality	Central Position N.	Central Position E.	Depth in m	Temp. ° C. Surface	Temp. ° C. Bottom	Salinity ‰ Surface	Salinity ‰ Bottom	Depth of fishing	Duration of fishing hours	No. of larvae caught	Length in mm minimum	Length in mm maximum	Length in mm average
185	1904 Febr. 17	6.5 miles WNW of Hirshals	57°37′	9°45′	30	2.7	..	34.0	..	Surface	1/4	10	23	33	29
186	— — —	18 miles WNW of Hirshals	57°39′	9°26′	26	3.3	..	34.3	..	Surface	1/4	7	15	28	23
187	— — —	25 miles WbyN of Hirshals	57°40′	9°12′	42	3.7	..	34.5	..	Intermediate	1/4	4	12	21	18
188	— — —	1 mile SE1/2S of Oxø	57°46′	8°49′	210	3.3	..	33.0	..	Intermediate	5/6	2	23	36	30
190	— — —	23 miles SE1/2S of Oxø	57°49.5′	8°37′	425	..	..	..	..	Intermediate	1/2	2	..	26	..
202	— — 26	8 miles SW1/2S of Graadeep Buoy	55°19′	8°08′	14	1.1	..	..	..	Surface	1/2	1	..	..	24
										Near bottom	1/2	2	39	41	40
203	— — —	5 miles SW3/4S of Graadeep	55°21.5′	8°10.5′	13	1.5	..	31.8	..	Surface	1/4	2	..	24	..
										Near bottom	1/6	0	..	..	..
220	— March 16	5 miles NE by E of Skagen L.V.	57°49.5′	10°50′	88	0.3	..	..	..	Intermediate	1/2	3	..	..	..
221	— — —	7 miles NE by E of Skagen L.V.	57°52.5′	10°48′	135	1.1	5.4	25.9	33.3	Surface	1/2	2	24	28	26
222	— — —	9 miles NNE1/2E of Skagen L.V.	57°55′	10°47.5′	170	0.1	5.6	24.6	34.9	Near bottom	1/2	1	..	..	..
349	1905 March 20/22	2 miles W of Spirbakken Bro	57°42′	10°23′	17	3.3	3.5	32.2	32.3	Intermediate	1	4	..	..	..
										Near bottom	1/2	3	..	..	..
351	— — 22/23	9 miles WNW of Kjettrup Bro	57°20′	9°24′	9	2.3	..	32.1	..	Intermediate	8	130	..	..	..
352	— — 23	29 miles WNW of Hanstholm	57°14′	7°43′	50	4.9	5.0	35.0	35.1	Intermediate	6	20	..	..	..
353	— — 24	2.5 miles W of Lodbjerg Light	56°49′	8°12′	17	3.6	4.0	32.1	34.0	Intermediate	8	1100	24	43	..
354	— — —	3 miles W of Torup Bro	56°58′	8°18′	18	3.9	4.0	33.5	33.9	Near bottom	1	20	20	30	..
367	— April 7	13.5 miles NE by E of Skagen L.V.	57°56′	11°00′	105	4.2	5.0	34.0	34.8	Near bottom	1/2	1	..	..	..
369	— — 8	32 miles N3/4W of Hirshals	58°05′	9°36′	414	3.9	..	32.3	..	Surface	2	9	25	37	..
										Intermediate	2	0	..	..	..
372	— — 9	18 miles NW by W1/2W of Bovbjerg Light	56°35′	7°35′	27	4.8	5.3	34.7	34.7	Surface	1/2	20	20	35	..
373	— — —	10 miles N by W of Horns Reef L.V.	55°44′	7°13′	27	4.5	4.8	33.5	33.6	Near bottom	2	200	22	40	..
380	— — 14	Dogger Bank, Tail End	55°33′	4°39′	32	5.5	5.5	34.8	34.8	Surface	2	100	32	38	..
										Intermediate	3	125	33	38	..
381	— — 15	8 miles SSW of Blaavand Point	55°26′	8°02′	14	4.4	4.5	30.5	30.6	Near bottom	1/2	10	35	45	..
382	— — 15	Slugen, North	55°36′	7°50′	15	4.2	4.5	31.1	31.3	Intermediate	1/2	25	22	46	..
										Near bottom	1/4	8	25	41	..
741	1906 March 19	16 miles E1/2S of Skagen L.V.	57°48′	11°13′	65	2.9	3.8	32.4	34.4	Surface	3	1650	..	32	..
										Near bottom	5	1150	..	33	..
751	— — 23	15 miles NE by N of Skagen L.V.	57°58′	10°50′	140—188	2.6	5.1	32.9	35.0	Surface	1	1	..	..	35
										Intermediate	2	2	..	..	25
										Near bottom	4	0	..	..	..
754	— — 23	32 miles N by W of Højen Light	58°15′	10°09′	550	3.5	5.3	33.1	34.9	Surface	2	5	24	37	..
758	— — 24	11 miles N1/2W of Skagen L.V.	57°56′	10°32′	97	3.7	..	33.8	..	Surface	1	96	12	35	..
759	— — 24	3 miles N by E of Skagen L.V.	57°47′	10°38′	85	2.5	..	31.5	..	Surface	1	142	..	32	..
770	— — 30	7 miles E1/2N of Hirshals Light	57°37′	10°09′	13	2.6	4.1	30.2	33.1	Surface	3	61	18	38	..
										Intermediate	3	6000	..	40	..
782	— April 3/4	23 miles NW1/4N of Hirshals Light	57°49′	9°22′	105	4.3	5.6	..	..	Intermediate	1/2	1	..	..	27
783	— — 3/4	42 miles NW1/4W of Hirshals Light	57°57′	8°50′	510	3.5	5.7	..	..	Intermediate	1	21	18	34	..
784	— — 4	9 miles E by S of Oxø Light	58°05′	8°21′	108	3.2	5.3	33.4	34.9	Surface	1	1	..	..	35
787	— — —	9 miles NW1/2W of Hanstholm	57°11′	8°21′	25	5.0	4.6	35.0	34.9	Surface	1	0	..	..	..
										Intermediate	1	1	..	..	22
788	— — —	2.5 miles W by N1/2N of Thyborøn Bro	56°42′	8°08′	15	4.7	3.5	33.8	34.7	Surface	1	120	15	42	..
789	— — 5	23 miles NW1/2W of Bovbjerg	56°40′	7°29′	31	4.5	5.0	34.8	35.0	Surface	1	5	21	35	..
791	— — —	38 miles W1/4S of Bovbjerg Light	56°20′	7°00′	37	4.2	4.5	34.4	34.6	Intermediate	1	38	20	32	..
792	— — —	34 miles N1/2W of Horns Reef L.V.	56°06′	6°58′	36	4.2	3.8	34.3	34.4	Intermediate	1	300	15	30	..
793	— — 5/6	22 miles NNW of Horns Reef L.V.	55°52′	6°56′	37	4.0	3.7	34.5	34.8	Surface	1	15	20	42	..
										Intermediate	1	100	14	40	..

Station No.	Date	Locality	Central Position N.	Central Position E.	Depth in m	Temp. ° C. Surface	Temp. ° C. Bottom	Salinity ‰ Surface	Salinity ‰ Bottom	Depth of fishing	Duration of fishing hours	No. of larvae caught	Length in mm minimum	Length in mm maximum	Length in mm average
794	1906 April 6	36 miles WNW of Horns Reef L.V.	55°42′	6°19′	47	4.5	3.9	34.9	34.9	Surface	1	1	..	..	19
										Near bottom	1	11	16	26	..
795	— — —	19 miles NW by W¾W of Horns Reef L.V.	55°37′	6°46′	38	4.1	3.8	34.1	34.8	Intermediate	2	200	13	37	..
796	— — 7	3 miles SW by W½W of Horns Reef L.V.	55°32′	7°15′	28	3.6	3.6	33.5	33.5	Intermediate	2	3400	18	38	..
798	— — —	1 mile NW of Vyl L.V.	55°24′	7°43′	20	3.9	3.8	33.5	33.4	Surface	1	7	12	22	..
802	— — 9	3 miles WNW of Kærgaarde Bn.	55°42′	8°04′	15	4.1	5.8	33.6	33.7	Intermediate	1	200	..	..	..
803	— — —	11 miles W of Haurvig Bn.	55°53′	7°51′	24	4.7	3.9	33.7	33.9	Intermediate	1	200	18	35	..
804	— — 9/10	17 miles W¼S of Søndervig	56°03′	7°38′	30	4.4	3.9	34.2	34.4	Intermediate	2	4000	15	42	..
806	— — 10	5 miles S by E of Blaavand Point	55°29′	8°09′	9	4.9	4.4	33.8	33.7	Surface	1	800	20	43	..
										Near bottom	½	0	..	..	..
939	1907 April 11	35 miles N¾W of Hirshals	58°08′	9°34′	500—600	4.4	5.8	32.9	35.0	Surface	1	0	..	..	..
										Intermediate	8	1	..	..	27
										Near bottom	2	0	..	..	..
940	— — 12	28 miles N½E of Hirshals	58°03′	9°49′	220	4.4	5.8	32.7	34.9	Surface	1	2	22	26	24
949	— — 15	6 miles NE by E½E of Hirshals	57°39′	10°05′	16	5.0	5.8	34.9	35.0	Surface	1	21	..	37	..
950	— — 16	19 miles W by S of Rubjerg Knude	57°18′	9°15′	17	5.2	4.8	34.3	34.3	Surface	2	77	18	38	..
955	— — —	17 miles NE by N of Hanstholm	57°22′	8°46′	28	5.3	5.4	34.3	34.9	Surface	3	38	21	41	..
956	— — 17	Off Thyborøn	56°46′ 56°42′	8°09′ 8°07′	19	5.5	5.6	32.6	33.6	Surface	3	384	26	41	..
960	— — 18	7 miles S by W of Blaavand Point	55°27′	8°05′	16	5.5	5.6	31.5	31.5	Surface	1	1500	23	44	..
982	— — 29	c. 5 miles NE½N of Horns Reef L.V.	55°39′	7°30′	17	5.4	5.9	32.8	32.8	Surface	3	300	24	44	..
983	— — 30	5 miles NE½N of Horns Reef L.V.	55°39′	7°30′	17	5.9	5.8	32.8	32.8	Intermediate	3	4200	..	..	..
2991	1923 April 29	9.5 miles SW by S of Paternoster Light	57°45′	11°20′	85	6.1	6.2	23.0	35.0	Surface	½	0	..	..	..
										Intermediate	½	1	..	..	40
2992	— — —	7 miles NNW¼W of Måseskär Light	58°11.5′	11°13′	62	6.0	6.1	23.0	34.1	Surface	½	1	..	..	35
										Near bottom	½	0	..	..	..
2995	— — 30	Tannis Bay	57°40.5′	10°21′	10	6.6	6.7	34.5	34.4	Near bottom	½	43	43	53	46
2996	— — —	6 miles E½N of Hirshals Light	57°36.5′	10°08′	7	6.9	6.9	34.3	34.3	Near bottom	½	37	26	48	41
2997	— — —	17 miles W by S og Rubjerg Knude Light	57°21′	9°18′	15	6.0	5.7	33.7	33.8	Near bottom	½	15	29	43	36
2998	— — —	11 miles NE by E¼E of Hanstholm Light	57°14′	8°51′	23	5.5	5.4	33.8	33.8	Surface	½	0	..	..	..
										Near bottom	½	3	27	30	29
2999	— May 1	10 miles E by N¼N of Hanstholm Light	57°10.5′	8°53′	15	5.6	5.5	33.4	33.5	Intermediate	½	8	28	42	34
3000	— — —	1.5 mile N by E½E of Vigsø Bn.	57°07′	8°46′	7	6.1	5.7	33.6	33.8	Near bottom	½	2448	21	48	41
3001	— — 2	9 miles N½W of Lodbjerg Light	56°58′	8°12′	24	5.4	5.3	33.4	33.6	Surface	½	0	..	..	..
										Near bottom	½	1	..	..	28
3002	— — —	2 miles SW by W of Agger Bn.	56°44′	8°11′	9	6.1	5.8	33.1	33.1	Near bottom	½	24000	20	52	..
3003	— — —	7 miles W½N of Bovbjerg Light	56°30′	7°54′	24	6.5	5.5	32.7	33.0	Surface	½	0	..	..	..
										Near bottom	½	6	20	36	31
3004	— — —	12 miles W½N of N. Lyngvig Light	56°02′	7°45′	26	5.8	5.3	32.7	32.8	Surface	½	15	29	35	32
										Near bottom	½	12	25	37	34
3007	— — 5	23 miles SW¼W of Vyl L.V.	55°10′	7°05′	33	7.3	5.1	32.2	33.2	Surface	¼	6	28	34	31
										Near bottom	¼	2	34	39	37
3009	— — 6	25 miles NW by W¾W of Horns Reef L.V.	55°40′	6°35′	40	7.1	5.1	32.2	33.9	Surface	¼	0	..	..	..
										Near bottom	¼	2	36	40	38
3012	— — 7	32 miles W by N½N of Bovbjerg Light	56°34′	7°09′	31	6.1	4.7	32.8	33.9	Surface	¼	7	34	41	37
										Near bottom	¼	1	..	..	43

in the warm area where the maximum temperature is above 9° C, and that only a few spawning places are known in the cold area, where the maximum temperature is only 6—9° C.

It appears from Chap. II and Chap. IX that two different races of summer herrings are spawning in the northern part of the North Sea, and in all probability the Bank Herring is spawning in the warm area and the North Sea Deep Water Herring in the cold area. The samples of mature Bank Herrings

investigated were all taken in the warm area or on the boundary between the two areas. The samples of the North Sea Deep Water Herring investigated by BROCH (1906), originated from the following localities:

Tampen	61° 51′ N. 0° 45′ E.	13. Sept. 1904
Viking Bank (several samples)		October—November 1904
40 miles S. E. of Fair Isle	59° 14′ N. 0° 38′ W.	10. Sept. 1904. (comp. p. 6—11).

These localities are all situated in the cold area.

The Bank Herring in the northern part of the North Sea is spawning in the period when the water is warmest: viz. August—September, but the Bank Herring on the Dogger Bank and off the English East Coast between 53° and 55° N. lat. is spawning later in autumn viz. September—November, with maximum in October, when the cooling of the water has begun. In this way the temperature on the spawning places for the Bank Herring becomes rather similar on the northern and the southern spawning places at the time when the main spawning actually takes place.

Fig. 7 represents the spawning places of the summer herrings (of different races) in the northern part of the North Sea, according to BOWMAN, BJERKAN and WOOD, and the mean temperature at the sea bottom in August[1]). Fig. 8 shows the situation of the spawning places of the Bank Herring in the north western coastal area, according to FULTON (1891), and the mean temperature for August at 40 meters depth. Fig. 9 represents the approximate situation of the main spawning places of the Bank Herring in the southern area and the mean temperature at 40 meters depth in November.

If we consider the mean temperature at 40 meters depth in the north western spawning area in August, it will be seen that it is about 10—12° C. (Fig. 8). In the southern area the temperature is, on the whole, higher during this season (Fig. 7 and 8) and the spawning has not yet begun. In 20 meters depth the mean temperature for August is about 11° C at the Shetland Isles and between 12 and 13° C in the area east of Scotland, but from 14 to 16° C on the Dogger Bank, and 13 to 15° C in the area between Flamborough Head and Cromer. At 60 meters depth the mean temperature is about 10° C at the Shetland Isles and in the area east of Scotland, and at 80 m about 9—10° C. Thus it appears that the spawning in the northern area at depths from about 20 to 80 meters takes place in August at a temperature of ca. 9—13° C, and the same temperature is prevailing in that area during September.

Turning now to the chart for November (Fig. 9) we find that the mean temperature at 40 m in the southern spawning areas is the same as that which we found in the north western spawning area in August, viz. 10—12° C. In the north western area the temperature is in November a little lower, about 9 or 10° C.[2]) In 20 meters depth and on the whole in the upper 40 meters layer the temperature is about the same as at 40 meters. During the main spawning period in October the temperature is somewhat higher on the southern spawning places, namely about 11—13° C.

According to REDEKE (1918) no spawning of herrings takes place in autumn in the south western part of the North Sea south of 53° 0′ N. lat. The temperature here in September—October is more than 13° C. on the sea bottom.

The spawning in the eastern area around the Little Fisher Bank and Jutland Bank occurs in September—October. The temperature here is, in August, at 40 meters depth, about 8—10° C, but if we look at the chart showing the maximum temperature at the bottom of the North Sea, we see that a higher temperature of 10—12° C (Fig. 6) prevails there in the warmest period of the year, and that coincides with the spawning period in September—October.

[1]) The isotherms are taken from Bulletin Trimestriel 1906—07, Partie Supplémentaire, and the means are calculated for the period from August 1902 to May 1905. The isotherms and isohalines represented on Fig. 8—11 cover the same period.

[2]) In Bulletin Trimestriel, Partie Supplémentaire 1906—07, an isoterm of 11° C. giving the mean temperature on the sea bottom for November is drawn on the stretch Aberdeen-Tynemouth. It seems to be a mistake for 10° C.

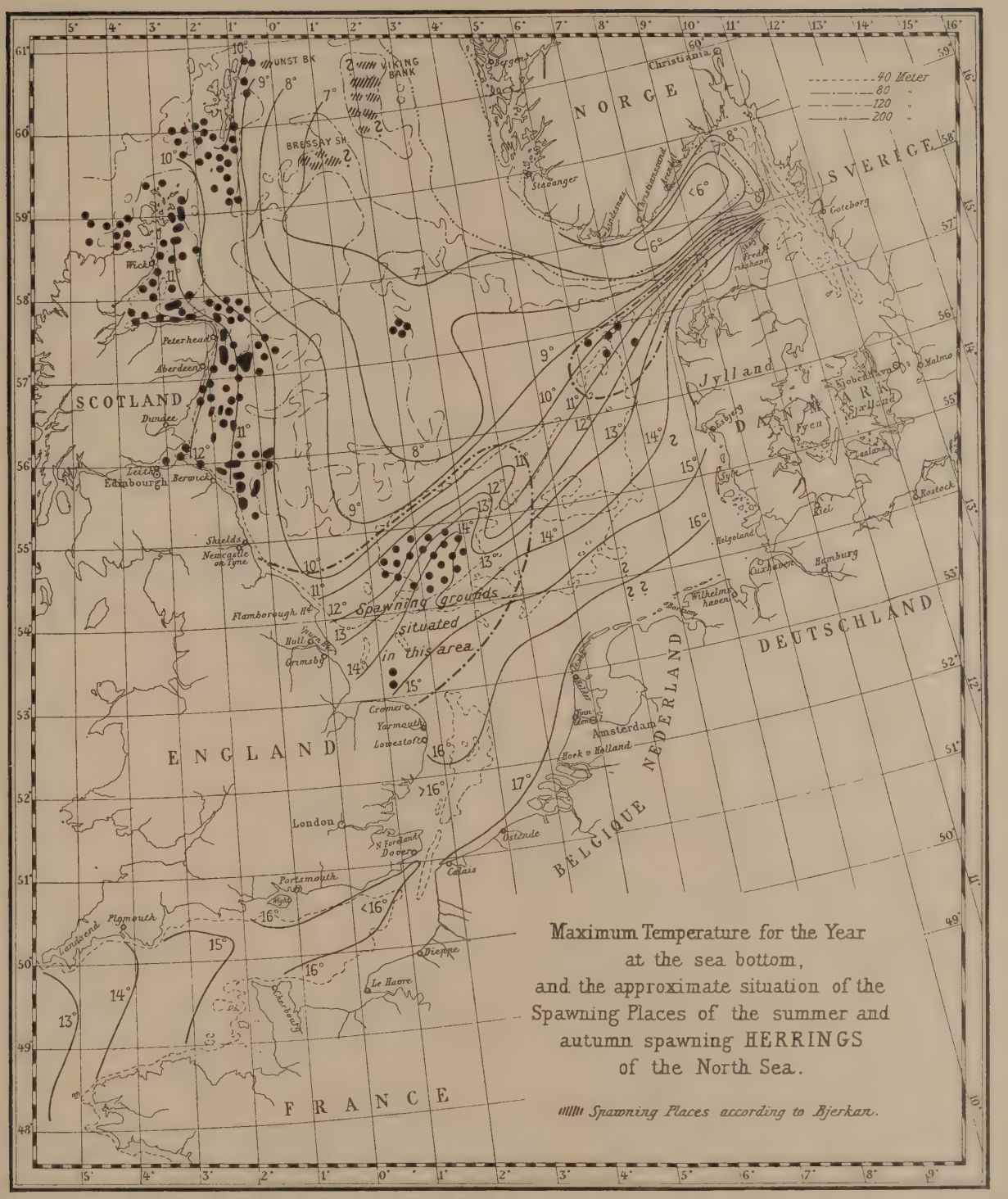

Fig. 6. Maximum temperature for the year at the sea bottom and the approximate situation of the spawning places of the summer and autumn spawning herrings of the North Sea, according to the information available (comp. Chap. IX).

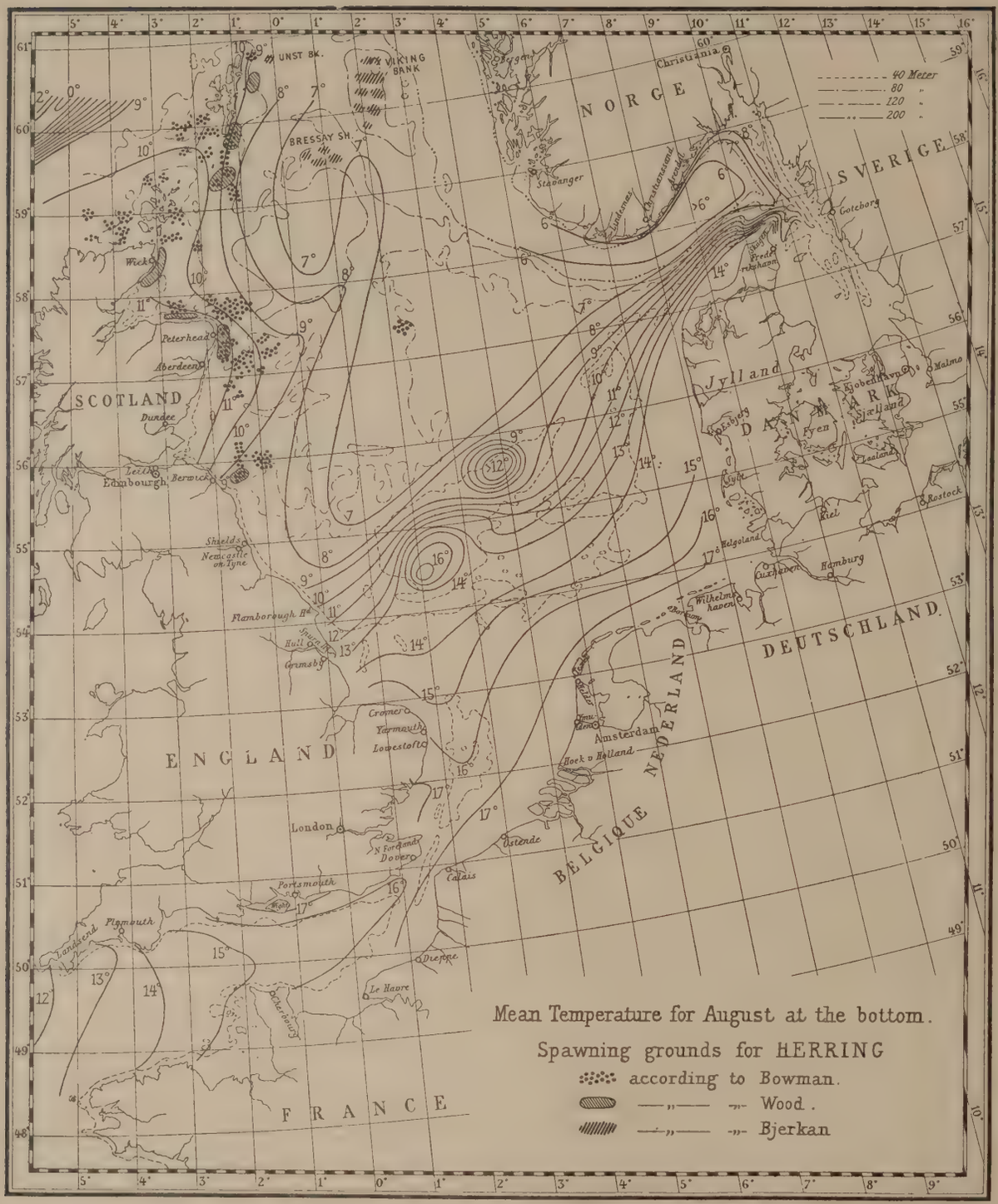

Fig. 7. Mean temperature for August at the sea bottom and the approximate situation of spawning grounds of the summer spawning herrings in the northern part of the North Sea, after BOWMAN, WOOD and BJERKAN (Comp. Chap. IX).

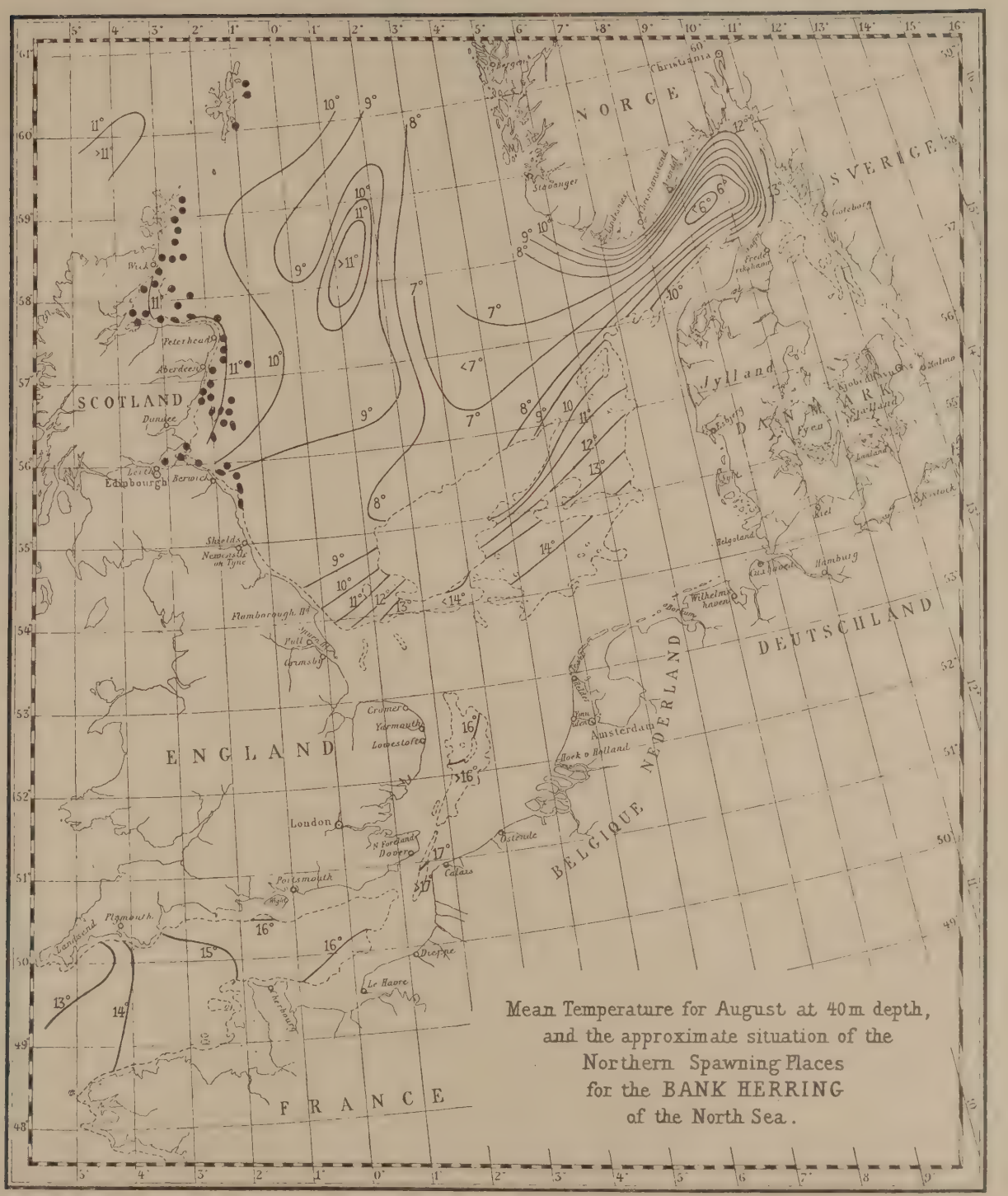

Fig. 8. Mean temperature for August at 40 m depth, and the approximate situation of the principal north-western spawning places for the Bank Herring, after FULTON.

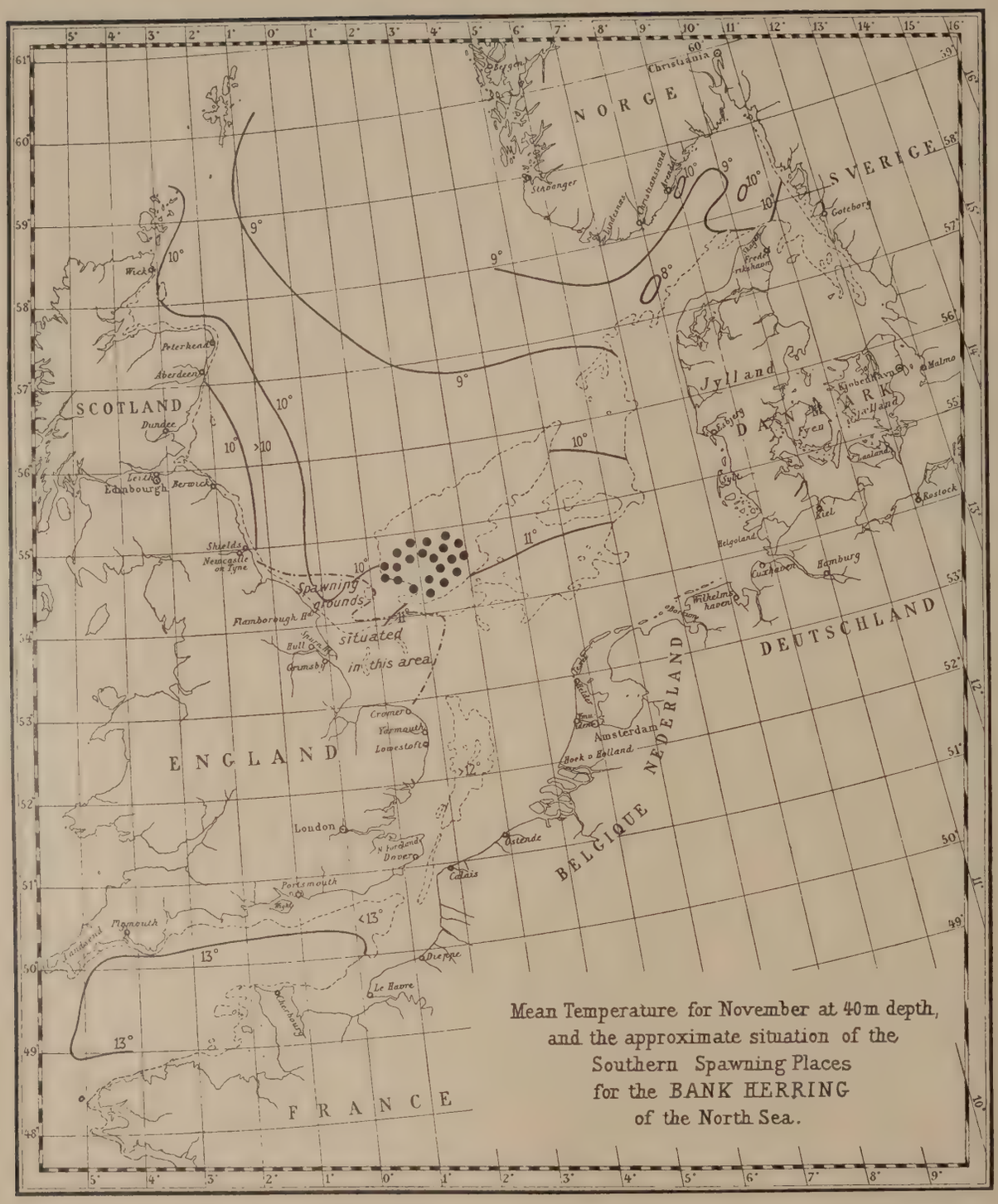

Fig. 9. Mean temperature for November at 40 m and the approximate situation of important spawning grounds for the Bank Herring on the Dogger Bank and the area between the Dogger Bank and the English coast.

Thus it will be seen that the mean temperature at the spawning places for the Bank Herring during the period when spawning actually takes place probably lies between 9° and 13° C, and the main spawning probably occurs at a temperature of about 10—12° C. The temperature varies at a certain depth from one year to another, but it is not known whether this variation causes a change in the depth or locality of the spawning places.

Fig. 10 represents the mean salinity for the year at the bottom of the sea, together with a sketch of the approximate position of the known spawning places of the summer and autumn spawning herrings of the North Sea.

As shown by D'Arcy Thompson (1909) the yearly variation in the salinity is, on the whole, slight at the bottom of the North Sea. Its mean value amounts only to about 0.1 to 0.5 pro mille in the places where the Bank Herrings have their spawning grounds. It will be seen therefore, that the mean salinity of the water in the different places in the North Sea where the Bank Herring has its spawning places, lies between 34.0 and 35.2‰. The salinity on the different spawning places for the North Sea Deep Water Herring differs very little from 35.2‰.

The situation of the spawning places of the Autumn Herrings of the German Bight is not known, but as on the whole there is muddy bottom in the small area of the German Bight where the depths are above 40 meters, we must conclude that the spawning places occur at depths below 40 meters. The spawning probably takes place in the period September—October, and perhaps mainly in October. The mean temperature on the sea-bottom at depths from 20—40 meters is in September about 14—16° C, in October 12—13° C. The mean salinity at the same depths is in September—October about 32—34‰. Thus it appears that the temperature is a little higher and the salinity somewhat lower than the values we observed on the spawning places for the Bank Herring of the North Sea.[1])

We can now give the following provisional survey of the temperature and salinity at the spawning places for the summer and autumn spawning herrings of the North Sea during the spawning period.

	Temp.° C.	Salinity ‰
The North Sea Deep Water Herring	6— 9	ca. 35.2
The Bank Herring of the North Sea	9—13	34.0—35.2
The Autumn Herrings of the German Bight	12—14	32.0—34.0

Thus we see that the morphological differences observed are accompanied by differences regarding temperature and salinity at the spawning places.

XI. On the Differences between the Bank Herring of the North Sea and various other Herring Races in the North Sea and adjacent waters.

It has been shown in the present paper that small differences occur between the Bank Herring of the North Sea and two other groups of summer or autumn spawning herrings occurring in the North Sea, viz. the North Sea Deep Water Herrings, and the Autumn Herrings of the German Bight. In the following will be mentioned some differences observed between the Bank Herring of the North Sea and various other sea herrings occurring in the North Sea or adjacent waters, viz.

[1]) An autumn spawning coast herring, of little importance, which has a lower number of vertebrae than the Bank Herring of the North Sea, occurs in the western part of the Lim Fiord, where the mean salinity is about 30—31‰. It would be worth while to investigate whether such autumn spawning coast herrings occur also in other fiords or coastal waters of the North Sea e. g. in The Wash and adjacent waters.

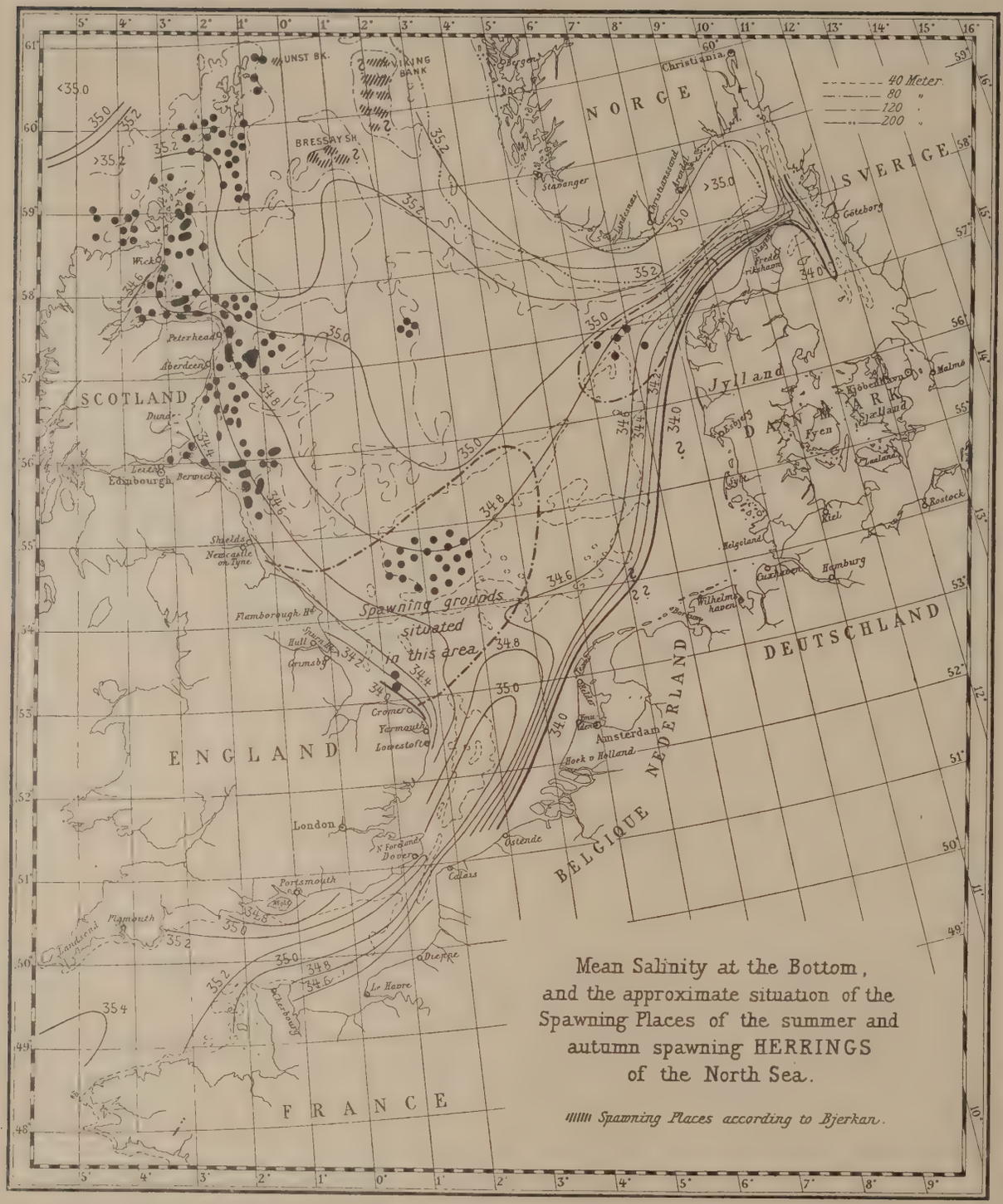

Fig. 10. Mean salinity for the year at the sea bottom, and the approximate situation of the spawning places of the summer and autumn spawning herrings of the North Sea, according to the information available (comp. Chap. IX).

1) The autumn spawning herrings of the North Eastern Kattegat (The "Kobbergrund Herrings").
2) The winter spawning herrings of the Kattegat.
3) The Atlanto-Scandian Herring.
4) The Scotch Spring Herring.
5) The Channel Sea Herring.
6) The West Channel Winter Herring.

A. The Autumn Spawning Herrings of the North Eastern Kattegat (The "Kobbergrund Herrings").

In the north-eastern Kattegat, east of Læsø and east of the plateau between Læsø and Anholt, a considerable herring fishery takes place from the beginning of September until December. From Sweden this fishery is mainly carried out by purse seine, from Denmark mainly by drift-nets. The most important part of the fishery is usually concentrated in the region ot the Kobbergrund, Groves Flak, Fladen and Little Middelgrund.

It is not exclusively autumn-spawning herrings which are captured in this area. Winter-spawning and spring-spawning herrings are taken also, and these may form a considerable part of the catch (A. C. Johansen 1923).

Heincke has, in *"Naturgeschichte des Herings"* (1898), described a sample of herrings captured in the eastern Kattegat off Varberg on October 10. 1887. The sample comprised 67 specimens of a length from 26—30 cm and of maturity IV—VII. His analysis for the individually constant characters gave the following result:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	3	22	2	29	1	13	9	16	10
56	28	23	8	30	4	14	21	17	7
57	24	24	25	31	14	15	20	18	39
58	2	25	13	32	13	16	3	19	1
..	..	26	8	33	20	17	..	..	..
..	..	27	1	34	5	18	1	..	..
n	57		57		57		54		57
m	56.44		24.35		32.09		14.39		17.54
σ	0.66		1.06		1.18		0.96		0.80
σ_m	0.087		0.141		0.157		0.130		0.106
σ_σ	0.061		0.099		0.111		0.092		0.075

For 10 specimens only Vert. S. were examined. If we include these we obtain a mean value for Vert. S. of 56.37 ± 0.085.

The comparatively high number of precaudal vertebrae in connection with a comparatively low number of keeled scales and ventral fin rays is peculiar to this herring.

From Dr. K. A. Andersson I have received a sample of herrings captured by Swedish purse seine fishermen (on October 23. 1915) in the neighbourhood of the Kobbergrund at ca. 57° 08′ N. 11° 23′ E. The sample consisted of about 300 specimens of the following stages of maturity:

26	specimens of maturity	I—II	(young herrings)
43	—	II—III	(spring-spawning herrings)
40	—	V	(winter-spawning herrings)
178	—	VII	(autumn-spawning herrings)

The sample is described in my previous paper: "Ueber die Winterheringe des Kattegats" 1923.

The 178 specimens of maturity VII were of the following lengths:

cm	♂	♀	♂+♀
21	..	1	1
22	1	..	1
23	2	..	2
24	5	7	12
25	11	11	22
26	10	11	21
27	16	16	32
28	33	15	48
29	11	19	30
30	1	8	9
Total	90	88	178
Aver. length cm[1]	27.49	27.69	27.58

[1] Corrected by adding 0.5.

The analysis gave the following result for the individually constant characters:
Kobbergrund. 23. October 1915. Herrings of Maturity VII.

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	16	22	3	28	1	13	8	16	43
56	90	23	27	29	7	14	78	17	27
57	66	24	61	30	21	15	66	18	105
58	6	25	50	31	36	16	25	19	3
..	..	26	27	32	59	17	1	..	..
..	..	27	10	33	44	..	..	..	..
..	..	..	..	34	10	..	..	..	..
n	178		178		178		178		178
m	56.35		24.57		31.78		14.62		17.38
σ	0.691		1.14		1.25		0.802		0.870
σ_m	0.052		0.085		0.093		0.060		0.065
σ_σ	0.037		0.060		0.066		0.0425		0.046

The sample at hand has the same racial characters as the sample from Varberg investigated by Heincke. The sample is evidently not a mixture of the North Sea Bank Herring and a smaller autumn spawning Kattegat Herring. Our investigation of the correlation between length and number of vertebrae gives the following result:

Number of vertebrae	Length in cm										Σ_I
	21	22	23	24	25	26	27	28	29	30	
55	..	..	..	1	1	2	3	5	4	..	16
56	..	1	2	8	12	12	12	25	15	3	90
57	1	..	..	3	8	6	16	17	9	6	66
58	..	..	..	..	1	1	1	1	2	..	6
Σ_{II}	1	1	2	12	22	21	32	48	30	30	178

From this we obtain the correlation coefficient $r = 0.041 \pm 0.075$.

Thus the number of vertebrae is practically the same in the smaller as in the larger specimens.

This herring differs in its racial characters distinctly from the North Sea Bank Herring. If we compare the sample from the Kobbergrund with the sample of Scotch Summer Herrings from Balta Sound investigated by me, we obtain the following result:

363 Scotch Summer Herrings (1. Sept. 1921) minus 178 Kobbergrund Herrings (Oct. 23. 1915).

Diff.	Vert. S.	0.15	Standard Dev. of Diff.		0.06
—	Vert. præc.	—0.73	—	— - —	0.10
—	Vert. caud.	0.89	—	— - —	0.105
—	K_2	0.23	—	— - —	0.075
—	Ventr. Rays	0.35	—	— - —	0.07

It will be seen that considerable differences occur in the number of caudal and precaudal vertebrae as well as in the number of ventral fin rays.

A sample of herrings caught in drift nets at Groves Flak, 57° 08′ N. 11° 35′ E., on October 7. 1922, consisted almost exclusively of autumn spawners. Four hundred specimens of maturity VI have been investigated. Their lengths were as follows:

cm	♂	♀	♂+♀
20	3	1	4
21	33	8	41
22	55	24	79
23	45	19	64
24	33	14	47
25	37	24	61
26	27	24	51
27	25	13	38
28	4	7	11
29	3	1	4
Total	265	135	400
Aver. length cm[1]	23.77	24.36	23.94

[1] Corrected by adding 0.5.

The distribution of the variants for the individually constant characters was as follows:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
52	1	20	1	28	2	13	33	14	3
53	..	22	7	29	4	14	135	15	2
54	1	23	94	30	47	15	176	16	61
55	52	24	158	31	73	16	48	17	42
56	248	25	91	32	145	17	5	18	285
57	93	26	37	33	119	18	3	19	2
58	5	27	10	34	8	..	..	20	3
..	..	28	2	35	2	..	..	..	..
n	400		400		400		400		398
m	56.11		24.23		31.885		14.665		17.56
σ	0.67		1.09		1.11		0.89		0.85
σ_m	0.034		0.055		0.056		0.045		0.043
σ_σ	0.024		0.039		0.039		0.032		0.030

Rays in dorsal fin				Rays in anal fin			
branched		total		branched		unbranched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
14	39	15	7	12	7	2	8
15	216	16	29	13	37	3	346
16	139	17	155	14	162	4	41
17	4	18	161	15	154	..	..
..	..	19	39	16	33	..	..
..	..	20	4	17	2	..	..
n	398		395		395		395

m	15.27	17.53	14.44	3.08
σ	0.64	0.87	0.86	0.34
σ_m	0.032	0.044	0.043	0.017
σ_v	0.023	0.031	0.031	0.012

Comparing this sample with the sample of 178 herrings from Kobbergrund, 23. Oct. 1915, we obtain the following result:

178 autumn herrings, Kobbergrund, minus 400 autumn herrings, Groves Flak.

Diff. Vert. S.	0.24	Standard Dev. of Diff.	0.06
— Vert. præc.	0.34	— — - —	0.10
— Vert. caud.	—0.10	— — - —	0.11
— Keeled scales K_2	—0.05	— — - —	0.08
— Ventral fin rays	—0.18	— — - —	0.08

The numerical differences are only small, but in case of Vert. S. and Vert. præc. they have a value of 3 to 4 times the standard deviation of the difference.

If we compare the sample from Groves Flak with the sample of Scotch Summer Herrings from Balta Sound, we get the following result:

363 Scotch Summer Herrings, Balta Sound, minus 400 autumn herrings, Groves Flak.

Diff. Vert. S.	0.39	Standard Dev. of Diff.	0.05
— Vert. præc.	—0.39	— — - —	0.07
— Vert. caud.	0.78	— — - —	0.075
— Keeled Scales (K_2)	0.18	— — - —	0.06
— Ventr. fin rays	0.17	— — - —	0.06
— Branched dorsal rays	—0.17	— — - —	0.05
— Total anal rays	—0.42	— — - —	0.07
— Branched anal rays	—0.39	— — - —	0.065
— Unbranch. anal rays	—0.02	— — - —	0.03

Real differences occur here for almost all characters except for the unbranched anal fin rays.

Having fresh material before me I investigated the state of maturity of about 1000 herrings caught on October 9. 1922 with purse seine by Swedish fishermen E. of Læsø at 57° 12′ N. 11° 19′ E. The investigation gave the following result:

5	specimens of maturity	I	(young herrings)
64	— - —	II	(spring-spawning herrings)
44	— - —	III	(mainly spring-spawning herrings)
71	— - —	IV	(winter-spawning herrings)
c. 500	— - —	V, VI	(autumn-spawning herrings)
c. 300	— - —	VII	(autumn-spawning herrings)

The specimens of maturity I—IV are described in the paper: "Ueber die Winterheringe des Kattegats" (A. C. Johansen 1923).

Of the herrings of maturity VII, 120 specimens have been analysed. Their lengths were as follows:

cm	♂	♀	♂+♀
21	2	2	4
22	6	13	19
23	11	12	23
24	8	1	9
25	19	11	30
26	10	7	17
27	5	6	11
28	2	3	5
29	..	2	2
Total	63	57	120
Aver. length cm[1]	24.52	24.37	24.45

[1] Corrected by adding 0.5.

The distribution of the variants for the individually constant characters was as follows:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
53	1	22	3	29	5	12	1	14	1
54	..	23	24	30	8	13	12	15	1
55	18	24	55	31	21	14	49	16	29
56	69	25	23	32	49	15	49	17	15
57	29	26	12	33	34	16	7	18	72
58	3	27	3	34	3	17	1	19	2
..	..	..	..	..	..	18	1	..	..
n	120		120		120		120		120
m	56.12		24.22		31.90		14.47		17.35
σ	0.75		0.98		1.10		0.88		0.95
σ_m	0.068		0.089		0.100		0.080		0.087
σ_σ	0.048		0.063		0.071		0.057		0.061

Rays in dorsal fin				Rays in anal fin			
branched		total		branched		unbranched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
14	5	16	9	13	10	2	1
15	56	17	36	14	41	3	103
16	55	18	52	15	49	4	14
17	3	19	18	16	18	..	..
..	..	20	3	..	..	..	..
n	119		118		118		118
m	15.47		17.75		14.64		3.11
σ	0.62		0.90		0.84		0.34
σ_m	0.057		0.083		0.078		0.031
σ_σ	0.040		0.058		0.055		0.022

It will be seen that no real difference is found to exist between the sample of maturity VII from Læsø (9—10—22) and the sample from Groves Flak (7—10—22).

The samples mentioned above, have not a uniform racial stamp.[1] We shall here compare the mean values found for the main characters investigated:

Locality	Date	No. of specimens	Maturity	Vert. S.	Vert. præc.	Vert. caud.	K_2	Rays in ventral fins	Branch. dorsal fin rays	Total anal fin rays
Off Varberg	10. 10. 1887	57—67	IV—VII	56.37	24.35	32.09	14.39	17.54		
Kobbergrund	23. 10. 1915	178	VII	56.35	24.57	31.78	14.62	17.38		
Groves Flak	7. 10. 1922	400	VI	56.11	24.33	31.89	14.665	17.56	15.27	17.53
E. of Læsö	9. 10. 1922	120	VII	56.12	24.22	31.90	14.47	17.35	15.47	17.75

It will be seen that the Autumn Herrings of the North Eastern Kattegat differ from the Bank Herring of the North Sea by a lower number of Vertebrae (Vert. S. and Vert. caud.), keeled scales (K_2), fin rays in the ventral fins, and by a higher number of fin rays in anal fin.

[1] In the northern Kattegat a herring race occurs, which is spawning in autumn in shallow water. A sample of 116 specimens probably belonging to this shallow water herring, was picked out by the author from the catch E of Læsø mentioned above. The herrings were of maturity V and their lengths varied from 19 to 28 cm (average 24.5 cm). The mean values found for these specimens were as follows (A. C. Johansen 1923):

Vert. S. $= 56.04 \pm 0.076$, Vert. præc. $= 24.02 \pm 0.084$, Keeled Scales (K_2) $= 14.77 \pm 0.082$, Rays in ventral fins $= 17.73 \pm 0.074$, Branched dorsal fin rays $= 14.94 \pm 0.059$. Total anal fin rays $= 17.51 \pm 0.082$.

It will be noticed that this herring in many respects resembles the Bank Herring of the North Sea but that it differs from it by a lower number of vertebrae.

Still more differing from the Bank Herring of the North Sea are the autumn spawning herrings of the middle and southern Kattegat, the Sound, the Belt Sea and the Baltic (Heincke 1898, A. C. Johansen 1915, 1916, 1923). The further we go towards South into the Kattegat and Belt Sea and towards East into the Baltic, the lower is the number of vertebrae and the number of keeled scales, and the smaller are the herrrings at first maturity.

Fig. 11. Mean temperature and salinity in the Kattegat on November 1st and the position of the observed spawning places for the Autumn Herrings of the North Eastern Kattegat. (Temperature and Salinity after J. P. Jacobsen 1908).

We have seen above that the autumn herrings from the northern Kattegat are different from the Bank Herring of the North Sea. It will now be of interest to investigate whether differences also occur in the temperature or the salinity on the spawning places for the two groups of herrings.

We have at hand only a few direct observations of eggs of the autumn herrings deposited on the sea bed in the north eastern Kattegat. Trybom has found the herring eggs at the sea bed at Groves Flak and at Fladen (Ekman, Pettersson and Trybom 1907). At the western side of Groves Flak at ca. 23 meters depth we have taken, by haul with a dredge, herring eggs attached to the alga *Desmarestia*. ("Dana" St. 2881. October 7. 1922, 57°05′5 N. 11° 32′ E.). With the research vessel "Thor" (St. 307 October 28. 1904) we had previously taken herring eggs from algae on the slope between the Kobbergrund and Anholt. The position of the station is 57° 01′ N. 11° 34′ E. and the depth 24—40 meters. In this particular area — around Fladen and Groves Flak and east of Kobbergrund — an important fishery of ripe herrings takes place in September and October and of spent herrings in October and November. Considerable captures of young herring fry have also been made here in autumn by the Danish research vessels (Figs. 1—2). There is therefore no doubt that important spawning places for the "Kobbergrund Herrings" occur here.

Only a few direct observations of the temperature and salinity at the spawning places of the "Kobbergrund Herrings" are available. On the station "Dana 2881" at Groves Flak October 7. 1922, mentioned above, the temperature was 13° C. and the salinity 33.3‰ at the depth of 23 meters from which the herring eggs were taken. At "Thor St. 307", in the neighbourhood of Kobbergrund, the temperature on October 28. 1904 was about 12° C. and the salinity about 34‰ within the depths from which the herring eggs were taken (24—40 m.)

For further information we will refer here to Fig. 11 showing the situation of some spawning places and the mean values for the temperature and salinity in Kattegat for November 1st, at 20 and at 40 meters depths. It will be seen that the salinity in the neighbourhood of the spawning places varies from about 29—32 pro mille at 20 meters depth, and from 33—34 pro mille at 40 meters depth. During the main spawning time in September and the beginning of October, the salinity is 0.2—0.5 pro mille lower. The

temperature is approximately 11° C. in November at 20 and 40 meters depth, but in the previous month, during the main spawning time, it is about 12—13° C at 20 meters depth.

Thus it will be seen, that the salinity at the spawning places of the "Kobbergrund Herrings" in the north-eastern Kattegat may be estimated to be about 29—34 pro mille, while the salinity at the spawning places for the Bank Herring of the North Sea is about 34.0—35.2 pro mille. As regards the temperature no difference is observed.

As mentioned above the "Kobbergrund Herrings" have not a uniform racial stamp. In this connection it should be noted that the salinity in the Eastern Kattegat varies greatly with the depth, and that herrings spawning in the same area, but at different depths, are spawning in water of different salinity.

B. The Winter Spawning Herrings of the Kattegat.

Morphological differences between the Bank Herring of the North Sea and the winter spawning herrings of the Kattegat are pointed out by the author (1923). The principal differences are here found in the total number of vertebrae, the number of keeled scales (K_2), the number of fin rays in the ventral fins, and the number of rays in the anal fin, as will appear from the survey of the mean values stated below:

	Bank Herring of the North Sea	Winter Herrings of the Kattegat
Total number of vertebrae	56.50 ± 0.05	56.83 ± 0.04
Number of keeled scales (K_2)	14.85 ± 0.07	14.20 ± 0.10[1] 14.70 ± 0.10[1]
Number of fin rays in ventr. fins	17.75 ± 0.05	17.95 ± 0.03
Number of fin rays in anal fin	17.20 ± 0.10	17.77 ± 0.12

The spawning period for the Winter Herrings of the Kattegat is January, February and March. The salinity on the spawning places varies probably from about 29 to 34 ‰, and the temperature from about 4 to 5° C. (A. C. Johansen 1923).

C. The Atlanto-Scandian Herring.

The Atlanto-Scandian Herring comprises the Norwegian Spring Herring and the Icelandic Spring Herring, both of which reach a much larger size than the Bank Herring of the North Sea.

Morphological differences between the large Atlanto-Scandian Herring and the Bank Herring have previously been demonstrated by the author (1919) and were partly pointed out formerly by Heincke (1898) and Broch (1908). The difference is particularly great in the case of the total number of vertebrae, the number of anal fin rays and the number of keeled scales (K_2). For these three characters the difference has a numerical value of about 1.0, the average being highest regarding the last characters and lowest regarding the two first characters for the Bank Herring of the North Sea.

The spawning period for the Atlanto-Scandian Herring is February, March and April. The salinity on the spawning places varies from about 33 to 35.2 ‰, and the temperature varies probably from about 4 to 7° C.

D. The Scotch Spring Herring.

The Scotch Spring Herring has been the object of racial investigations by Heincke (1898), who found that morphological differences exist between this herring and the summer spawning herring of Scotland etc.

The spawning period for the Scotch Spring Herring is January, February, March and April, and spawning grounds occur both off the west coast, the north coast, and the east coast of Scotland (Bowman 1923).

[1] Two different groups.

HEINCKE investigated 30 full herrings caught in February 1892, on Ballantrae Bank (S. W. Scotland), which is a well known spawning ground. Their lengths and state of maturity were as follows:

Length	Maturity		
cm	IV	V	VI
23	..	2	..
24	..	6	1
25	..	6	1
26	1	3	1
27	1	2	1
28	..	2	..
29	..	2	..
31	..	1	..
Total	2	24	4

The state of maturity leaves no doubt that the specimens were spring spawners. The distribution of the variants for the individual constant characters examined was as follows:

Vert. S.		Vert. præc.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
54	1	22	1	13	7	17	1
55	2	23	4	14	13	18	29
56	5	24	16	15	9	..	..
57	16	25	7	16	1	..	..
58	6	26	2	..	..	..	..
n	30		30		30		30
m	56.80		24.17		14.13		17.97
σ	0.96		0.87		0.82		0.17
σ_m	0.18		0.16		0.15		0.03
σ_o	0.12		0.11		0.11		0.02

HEINCKE made a racial study upon 31 badly preserved herrings caught at Barra (the Hebrides) on July 7. 1891. The specimens had a length from 23—31 cm. The main part of the sample were spring spawners of maturity II or VII, and HEINCKE observed the following distribution of the variants for vertebrae etc.:

Vert. S.		Vert. præc.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq	No.	Freq.	No.	Freq.
56	7	22	1	12	1	15	1
57	17	23	4	13	3	16	..
58	6	24	18	14	19	17	2
..	..	25	6	15	6	18	25
..	..	26	1	16	1	19	2
n	30		30		30		30
m	56.97		24.07		14.10		17.90
σ	0.67		0.79		0.76		0.66
σ_m	0.12		0.14		0.14		0.12
σ_o	0.09		0.10		0.10		0.09

HEINCKE investigated 30 herrings of 245—293 mm caught in the Firth of Forth in January 1892. He found the state of maturity as follows:

Length	Maturity				
cm	III	IV	V	V-VI	VI
24	..	..	1	..	1
25	1	1	4	1	..
26	..	..	4	..	3
27	..	..	5	4	..
28	..	..	3	..	..
29	..	..	2	..	..
n	1	1	19	5	4

There can be no doubt that all these specimens were spring spawners. The distribution of the vertebrae etc., found by HEINCKE, was as follows:

Vert. S.		Vert. præc.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
56	7	24	11	13	4	17	1
57	21	25	14	14	15	18	27
58	2	26	5	15	8	19	..
..	..	..	..	16	3	20	2
n	30		30		30		30
m	56.83		23.80		14.33		18.10
σ	0.53		0.71		0.85		0.55
σ_m	0.10		0.13		0.15		0.10
σ_σ	0.07		0.09		0.109		0.07

It will be seen that the three samples of spring spawners mentioned here all differ from the Bank Herring of the North Sea by having a greater number of vertebrae (Vert. S.) and of ventral fin rays, but a smaller number of keeled scales.

The samples investigated by HEINCKE seemed to have a rather uniform racial stamp.

As the view of HEINCKE about the differences between the spring spawners and summer spawners of Scotland etc. has been opposed by other authors, as MATTHEWS (1886—87) and JENKINS (1902), I found it desirable to undertake a comparison again between spring- and autumn spawners based on new material, and Mr. D. T. JONES has been kind enough to procure such material for me.

A sample of spring spawners, which I received from Mr. JONES, was caught 12 miles west of Cape Wrath (N. Scotland) on March 5. 1923. The lengths of the specimens varied from 26—32 cm, the average size being 29.9. Most of the specimens were of maturity VI, a few of maturity V and VII. The distribution of the variants for the individually constant characters examined was as follows:

Vert. S		Vert. præc.		Vert. caud.		K_2	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
56	32	23	56	31	14	12	4
57	174	24	128	32	60	13	71
58	60	25	71	33	123	14	143
59	4	26	14	34	68	15	48
..	..	27	1	35	5	16	4
n	270		270		270		270
m	57.13		24.17		32.96		13.91
σ	0.62		0.83		0.87		0.74
σ_m	0.038		0.050		0.053		0.045
σ_σ	0.027		0.036		0.037		0.032

Ventral Fin Rays		Dorsal Fin Rays Branched		Total		Anal Fin Rays Branched		Unbranched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
15	1	13	1	16	11	13	12	..	..
16	..	14	29	17	46	14	56	2	4
17	9	15	151	18	128	15	140	3	222
18	247	16	84	19	76	16	57	4	44
19	9	17	2	20	8	17	5	..	..
20	2	..	..	21	1	..	..	..	..
n	268		267		270		270		270
m	18.00		15.21		18.10		14.95		3.15
σ	0.36		0.65		0.87		0.82		0.40
σ_m	0.022		0.040		0.053		0.050		0.024
σ_σ	0.016		0.028		0.037		0.035		0.017

The racial characteristics of the Scotch Summer Herring are known from analyses of Heincke, Broch and Redeke and the author (see Chap. II and III). The largest sample examined is that from Balta Sound investigated by me. Comparing the Spring Spawners from Cape Wrath with the Summer Spawners from Balta Sound we obtain the following result:

363 Shetland Summer Herrings, Balta Sound, minus 270 Scotch Spring Herrings, Cape Wrath:

Diff.	Vert. S.	—0.63	Standard Dev. of Diff.		0.05
—	Vert. præc.	—0.33	—	— - —	0.07
—	Vert. caud.	—0.29	—	— - —	0.07
—	K_2	0.94	—	— - —	0.06
—	Ventr. fin. rays	—0.27	—	— - —	0.04
—	branch. dorsal rays	—0.11	—	— - —	0.05
—	total anal fin rays	—1.00	—	— - —	0.07
—	branch. anal fin rays	—0.91	—	— - —	0.07
—	unbr. anal fin rays	—0.09	—	— - —	0.03

It will be seen that for almost all characters there are essential differences between the samples, and these are especially great in the case of Vert. S., K_2 and anal fin rays.

For the characters treated by Heincke (Vert. S., K_2 and Rays in ventral fins) I have observed differences of at least the same magnitude as he has found.

The Shetland Spring Herring has a similar racial stamp as the Scotch Spring Herring from Cape Wrath investigated by me. A sample caught on March 21, 1923, 9 miles North of Flugga, consisted of 300 specimens of maturity VII, the lengths of which varied from 25—33 cm, average 29.6 cm. The distribution of the variants for the individually constant characters was as follows:

Vert. S.		Vert. præc.		Vert. caud.		K_2	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	2	22	1	29	1	12	6
56	40	23	39	30	6	13	89
57	197	24	129	31	23	14	165
58	57	25	95	32	102	15	39
59	4	26	32	33	112	16	1
..	..	27	3	34	32	..	..
..	..	28	1	35	4	..	..
n	300		300		300		300
m	57.07		24.44		32.63		13.80
σ	0.63		0.92		0.99		0.69
σ_m	0.036		0.053		0.057		0.040
σ_σ	0.026		0.037		0.040		0.028

Ventral Fin Rays		Dorsal Fin Rays Branched		Total		Anal Fin Rays Branched		Unbranched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
16	3	14	35	16	1	13	5	..	..
17	8	15	164	17	55	14	68	3	251
18	279	16	96	18	150	15	153	4	49
19	5	17	3	19	83	16	71	..	..
20	4	..	..	20	11	17	3	..	..
n	299		298		300		300		300
m	18.00		15.22		18.16		15.00		3.16
σ	0.37		0.66		0.77		0.76		0.37
σ_m	0.021		0.038		0.045		0.044		0.021
σ_v	0.015		0.027		0.032		0.031		0.015

Comparing this sample with the spring herring from Cape Wrath we obtain the following figures:

270 Scotch Spring Herrings, Cape Wrath minus 300 Shetland Spring Herrings, Flugga.

Diff.	Vert. S.	0.06	Standard Dev. of Diff.		0.05
—	Vert. præc.	—0.27	—	—	0.07
—	Vert. caud.	0.33	—	—	0.08
—	Keeled Scales K_2	0.11	—	—	0.66
—	branch. dorsal fin rays	—0.01	—	—	0.055
—	total anal fin rays	—0.06	—	—	0.07
—	branch. anal fin rays	—0.05	—	—	0.07
—	unbr. anal fin rays	—0.01	—	—	0.03

It will be seen that there is a small difference in the distribution of the caudal and precaudal vertebrae, while all the other characters agree very closely.[1]

If we compare the Shetland Summer Herring from Balta Sound with the Shetland Spring Herring from Flugga we obtain the following result:

363 Shetland Summer Herrings, Balta Sound, minus 300 Shetland Winter Herrings, Flugga.

Diff.	Vert. S.	—0.57	Standard Dev. of Diff.		0.05
—	Vert. præc.	—0.60	—	—	0.07
—	Vert. caud.	0.04	—	—	0.08
—	Keeled scales K_2	1.05	—	—	0.06
—	Ventral fin rays	—0.27	—	—	0.04

[1] The distribution of the specimens according to age agreed very closely in the two samples. In both samples the great majority of the specimens belonged to the year class 1918 (see p. 115).

It appears from the survey below that the Shetland Spring Herring (and therefore the Scotch Spring Herring) does not differ much from the summer-spawning Herring of Iceland examined by me (A. C. Johansen 1921 a):

477 summer herrings S. W. Iceland minus 300 spring herrings from the Shetland Isles:

Diff.	Vert. S.	—0.02	Standard dev. of Diff.		0.05
—	Vert. præc.	0.24	—	—	0.07
	Vert. caud.	—0.26	—	—	0.075
—	Keeled scales (K_2)	—0.22	—	—	0.05
—	Ventral fin rays	—0.09	—	—	0.04
	branch. dorsal fin rays	0.01	—	—	0.05
—	total anal fin rays	—0.01	—	—	0.06
—	branch. anal fin rays	0.07	—	—	0.06
—	unbr. anal fin rays	—0.08	—	—	0.03

A sample of young herrings caught at Kongshavn, the Faroes (16—8—19) and described by me (A. C. Johansen 1921 a) is also in near agreement with the Scotch and Shetland Spring Herring.

We have evidently a group of North East Atlantic Spring and Summer Herrings, occurring at Scotland, Shetland Isles, the Faroes and South and West Iceland, which are very near related to each other and may belong to one single race. This race differs from the Atlanto-Scandian Herring by a lower number of Vertebrae (Vert. S.).

Diff. branch. dorsal fin rays	—0.12	Standard Dev. of Diff.	0.05
— total anal fin rays	—1.05	— — - —	0.07
— branch. anal fin rays	—0.95	— — - —	0.07
— unbr. anal fin rays	—0.10	— — - —	0.03

For almost all characters there are essential differences between the samples. The greatest numerical differences occur in the number of keeled scales and the total number of anal fin rays where it exceeds 1.0.

The spawning places for the Scotch Spring Herring and the Shetland Spring Herring are probably situated at a depth of about 20 to 150 meters (comp. Ewart 1884 and Bowman 1923). The temperature in February and March varies here from about 5 to 8° C., and the salinity at least from 34.3 to 35.3‰.

E. The Channel Sea Herring.

The winter spawning Herring of the Channel and the south-western corner of the North Sea has been subjected to special race-studies by Sauvage et Canu (1892), Cligny (1904), Delsman (1913) and Redeke (1918).

Cligny (1904) has investigated the number of vertebrae of 125 winter spawning herrings captured in the southern part of the Channel in the neighbourhood of Cap d'Antifer in the winter of 1901—02.

The distribution of the variants was as follows:

Vert. S.		Vert. præc.	
No.	Freq.	No.	Freq.
55	7	23	5
56	48	24	33
57	62	25	58
58	8	26	19
..	..	27	2
..	..	28	2
n	125		119
m	56.57		23.88
σ	0.70		0.90
σ_m	0.063		0.083
σ_σ	0.044		0.059

Sauvage et Canu have examined the number of keeled scales of 416 winter spawning herrings captured in the neighbourhood of Boulogne in November—December 1892.

The distribution of the variants was as follows (Cligny 1904):

No.	12	13	14	15	16	17
Freq.	3	75	192	117	27	2

From this we get: $m = 14.23$, $\sigma = 0.86$, $\sigma_m = 0.042$ and $\sigma_\sigma = 0.030$.

Of the 416 specimens, 282 were investigated by Canu and 134 by Sauvage. The mean values for these groups were 14.3 and 14.1 respectively.

According to Cligny the herring captured in autumn near Boulogne belongs to the same race as the herring captured in January—March near Cap d'Antifer.

Delsman (1913) investigated 96 herrings of maturity III—V landed in Yarmouth on October 24. 1910. The lengths varied from 21—29 cm, and the average length was 25.5 cm. The number of vertebrae (Vert. S.) in 50 specimens was as follows:

No.	55	56	57	58
Freq.	1	24	24	1

Thus we get: $m = 56.50$, $\sigma = 0.58$, $\sigma_m = 0.082$ and $\sigma_\sigma = 0.058$.

Redeke has investigated 100 herrings of maturity III, IV (VI) and of lengths from 230—300 mm captured at station H 8 (ca. 52° 39′ N. 2° 30′ E.) on November $^5/_6$ 1905.

The distribution of the variants for vertebrae etc. was as follows:

Vert. S.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.
54	2	12	1	14	1
55	7	13	11	15	0
56	37	14	59	16	3
57	42	15	29	17	12
58	11	..	..	18	84
59	1	..	..	..	..
n	100		100		100
m	56.56		14.16		17.78
σ	0.89		0.65		0.60
σ_m	0.089		0.065		0.060
σ_σ	0.063		0.046		0.042

Redeke investigated 100 herrings of maturity (III) IV—V and of a length of 214—290 mm captured at 52° 43.5′ N. and 2° 50′ E. in November $^{15}/_{30}$ 1905. The variants are distributed in the following way:

Vert. S.[1]		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.
54	1	13	6	16	2
55	3	14	53	17	7
56	37	15	38	18	91
57	50	16	3	..	..
58	9	..	..	..	..
n	100		100		100
m	56.63		14.38		17.89
σ	0.73		0.65		0.37
σ_m	0.073		0.065		0.037
σ_σ	0.052		0.046		0.026

It will be seen that these samples have the same number of vertebrae and keeled scales as the herrings from the Channel investigated by Cligny, Canu and Sauvage. In the number of vertebrae, as well as in the number of keeled scales, the difference is less than twice the standard deviation of the difference. Redeke also was of the opinion that these samples belonged to the Channel Herring or to the same race as the samples investigated by Cligny, Canu and Sauvage.

The Channel Sea Herring has evidently a lower number of keeled scales than the North Sea Bank Herring.[2] If we compare the 363 Shetland Herrings investigated by me with the 416 Channel Herrings in-

[1] Dr. Redeke has kindly informed me, that the Vertebrae in this sample have been counted according to Orton's method, i. e. with the omission of the urostyle. Here, as in the other cases, the urostyle has been counted as one Vertebra.

[2] Redeke investigated 25 herrings caught in the south western part of the North Sea at 53° 06′ N. and 3° 0′ E. on November 7th 1906. The specimens were of an average length of 25.0 cm, and the maturity stage was III or IV for 22 specimens and VII for 3 specimens. It thus appears that we have to do mostly with herrings which spawn in winter and in a few cases with herrings spawning in autumn. The mean values found were as follows:

	Vert. S.	Vert. præc.	K_2	Rays in ventr. fins
m	56.56	23.84	15.00	17.84
σ	0.71	0.90	1.00	0.75
σ_m	0.14	0.18	0.20	0.15
σ_σ	0.10	0.13	0.14	0.11

Peculiar to this small sample is the high number of keeled scales, which agrees with that of the Bank Herring. The 3 herrings of maturity VII, which may have spawned in October or November, had respectively 15, 15 and 14 keeled scales, and therefore not a higher number than the specimens of maturity III and IV. We can not expect that the specimens of maturity III and IV would have spawned earlier than December. There seems to be a possibility that the sample belongs to a late spawning branch of the Bank Herring, and not to the Channel Herring.

vestigated by CANU and SAUVAGE, we obtain a difference of 0.62, the standard deviation of the difference being 0.06. The difference between the number of keeled scales in the Channel Sea Herring and in the Dogger Bank Herring is probably still greater. If we compare the 416 Channel Herrings with the 65 Dogger Bank Herrings investigated by REDEKE (see p. 15), we obtain a difference of 0.80 with a standard deviation of the difference of 0.11. The Channel Sea Herring has possibly also a little higher number of vertebrae than the North Sea Bank Herring. Of the Channel Sea Herring, 375 specimens had an average number of vertebrae of 56.57, while 803 mature Bank Herrings from various parts of the North Sea had an average number of vertebrae of 56.50.

The spawning period for the Channel Sea Herring is December, January and February. Important spawning places are situated in the eastern part of the Channel. According to REDEKE and VAN BREEMEN (1908) spawning places probably occur also in the North Sea near the entrance of the Channel. BORLEY and RUSSELL (1922) are of opinion that a large spawning ground for herrings spawning late in the season occurs in the neighbourhood of Smith's Knoll (see p. 27 of this paper).

The mean temperature on the spawning places is in January about 7—9° C., and in February 6—8° C. The salinity varies from about 34.4 ‰ to 35.3 ‰.

The temperature on the spawning places is for the Channel Sea Herring about the same as for the North Sea Deep Water Herring, and the morphological differences between these two groups of herrings also seem to be very small. The mean figures available for vertebrae, keeled scales and fin rays in ventral fins for the two races are as follows:

	Channel Sea Herring	North Sea Deep Water Herring
Vert. S.	56.57 ± 0.04 (375 spec.)	56.73 ± 0.07 (130 spec.)
Vert. præc.	23.88 ± 0.08 (119 —)	23.63 ± 0.07 (130 —)
K_2	14.24 ± 0.035 (616 —)	14.41 ± 0.07 (130 —)
Ventral fin rays	17.83 ± 0.04 (200 —)	17.76 ± 0.12 (36 —)

F. The West Channel Winter-Herring.

The winter spawning herring which occurs in the western part of the English Channel, has been made the subject of race-studies by the Biological Laboratory at Plymouth, and Dr. J. H. ORTON has published the results of the investigations in an important treatise: "An account of the Researches on Races of Herrings" (1916).

The samples examined were caught off Plymouth in December 1914 and January 1915. The lengths of the specimens varied from 22—28 cm, and the state of maturity was in most cases IV, V or VI, and in some cases III and VII. The spawning period for this herring is December, January and February.

The survey below, which is constructed on the basis of ORTON's tables, shows the distribution of the variants for the individually constant characters examined in about 1000 specimens of maturity III—VI.

Vert. S.		Vert. præc.		K_2	
No.	Freq.	No.	Freq.	No.	Freq.
55	13	22	23	12	1
56	295	23	356	13	39
57	626	24	502	14	335
58	85	25	130	15	533
59	2	26	10	16	106
..	..	..	..	17	6
..	..	..	..	18	1
n	1021		1021		1021
m	56.77		23.753		14.71
σ	0.63		0.738		0.74
σ_m	0.019		0.023		0.023
σ_σ	0.014		0.016		0.016

Rays in dorsal fin

Unbranched		Branched		Total	
No.	Freq.	No.	Freq.	No.	Freq.
2	35	13	1	16	1
3	753	14	22	17	12
4	202	15	251	18	185
..	..	16	549	19	550
..	..	17	166	20	235
..	..	18	1	21	7
n	990		990		990
m	3.169		15.869		19.037
σ	0.460		0.712		0.714
σ_m	0.015		0.023		0.023
σ_σ	0.010		0.016		0.016

Rays in anal fin

Unbranched		Branched		Total	
No.	Freq.	No.	Freq.	No.	Freq.
1	3	12	10	14	1
2	62	13	146	15	11
3	767	14	457	16	130
4	157	15	314	17	421
5	1	16	61	18	334
..	..	17	2	19	91
..	..	..	..	20	2
n	990		990		990
m	3.092		14.279		17.371
σ	0.479		0.832		0.878
σ_m	0.015		0.026		0.028
σ_σ	0.011		0.019		0.020

We shall now compare the sample of "Plymouth Herrings" investigated by ORTON and the sample of North Sea Bank Herring from the Shetland Isles investigated by me.

Plymouth Winter-Herring (Orton) minus North Sea Bank Herring from Balta Sound (Johansen).

Diff. Vert. S.	+ 0.27	Standard deviation of Difference			0.042
— Vert. præc.	— 0.08	—	—	—	0.051
— Vert. caud.	+ 0.35	—	—	—	c. 0.05
— K_2	— 0.14	—	—	—	0.051
— Dorsal, branched	+ 0.77	—	—	—	0.042
— Anal, unbranched	+ 0.04	—	—	—	0.027
— Anal, branched	+ 0.23	—	—	—	0.055
— Anal, total	+ 0.27	—	—	—	0.057

It will be noticed that we are dealing here with a real difference both in the number of vertebrae and in the number of dorsal and anal fin rays. The West Channel Winter Herring has a higher number of vertebrae and of dorsal and anal fin rays than the Bank Herring from the Shetland Isles. It will be seen from the survey below that the Plymouth Herring differs from the Channel Sea Herring in having a higher number of keeled scales and also a higher number of vertebrae.

1021 Plymouth Winter-Herrings (ORTON) minus 416 Channel Sea Herrings (CANU).

Difference $K_2 = 0.48$. Standard deviation of Difference 0.048.

1021 Plymouth Winter-Herring (ORTON) minus 125 Channel Sea Herring, Cap d'Antifer (CLIGNY).

Difference Vert. S. = 0.20. Standard deviation of Difference 0.066.

1021 Plymouth Winter-Herring (Orton) minus 100 Channel Sea Herring, North Sea St. H. 8 (Redeke).

Difference Vert. S. = 0.21 Standard deviation of Difference 0.091.

— K_2 = 0.55 — — - — 0.069.

The mean temperature at the bottom of the sea in the western part of the Channel is in December about 10—12° C and in February about 8—10° C. The mean temperature on the spawning places in the spawning period is then probably between 8 and 12° C. The mean salinity on the sea bottom lies between 35.2 ‰ and 35.4 ‰.

XII. Are the Summer- and Autumn-Spawning Herrings of the North Sea of importance for the great Winter Fishing in the Eastern Skagerak?

A. The Herring Fishery in the Eastern Skagerak.

In the period from December to March a great herring fishery takes place in the eastern Skagerak. The principal fishery is carried out from Bohuslän in Sweden, and the purse seine is the most important fishing gear used.

The main fishing takes place off the coasts of Bohuslän between Vinga and Hållö and westwards to the waters north of Skagen and Hirshals. At the end of the season (in March), the fishing places are usually situated off the stretch Skagen—Hirshals or even more westerly, to the North West of Rubjerg. (Fig. 15). A considerable herring trawling takes place from Germany in this last named area during the winter months, while Danish fishermen only to a small extent take part in the winter fishing in the eastern Skagerak.

The extremely great fluctuations in the yield of the Bohuslän herring fishery during winter are known from old times and are described and explained in different ways by various naturalists.

According to Ljungman (1879 (b)) and Pettersson (1922) we can distinguish between the following periods with alternately rich and poor fishing in the coastal region of Bohuslän.

1307—1362.....	very rich fishing, at least during the first third part of the century.
1363—1418.....	no rich fishing.
1419—1474.....	good yield, at least in the middle of the century.
1475—1530.....	no rich fishing.
1531—1586.....	very rich fishing, at least between 1556 and 1587.
1587—1642.....	no rich fishing.
1643—1698.....	good yield, at least between 1660 and 1680.
1699—1747.....	no rich fishing.
1748—1808.....	very rich fishing which in the last quarter of the century grew up to enormous dimensions.
1809—1877.....	no rich fishing.
1878—1896.....	rich fishing, especially between 1887—1896.
1897 and onwards...	a period with poor fishing has begun again.

Ljungman maintained that the secular periodicity in the yield corresponded with the periodicity of the solar spots, and he supposed that there was a connection between these phenomena.

The yield of the Bohuslän herring fishery in the period 1860—1923 is represented on Fig. 12 after Otto Pettersson. For the period prior to 1896 the yield was originally recorded by Dr. Malm, and for the period 1896—1921 the statistics are compiled by Dr. Hessle. For the years 1922 and 1923 the yield stated is only approximately. The yield for the period from $^1/_4$ 1922 to $^{31}/_3$ 1923 is put down under

1923 and a similar proceeding has been followed for the previous years. The statistics also include the yield of the herring fishery in Kattegat from Bohuslän.

The curve shows that the fluctuations are extremely great. Both the very small yield in the period prior to 1878 and the exceedingly large yield in the period 1887—1896 are very peculiar. In spite of the fact that a great development has taken place in the Swedish herring fishing since 1896, the very rich yield in the period 1887—1896 has never been approached since that time.

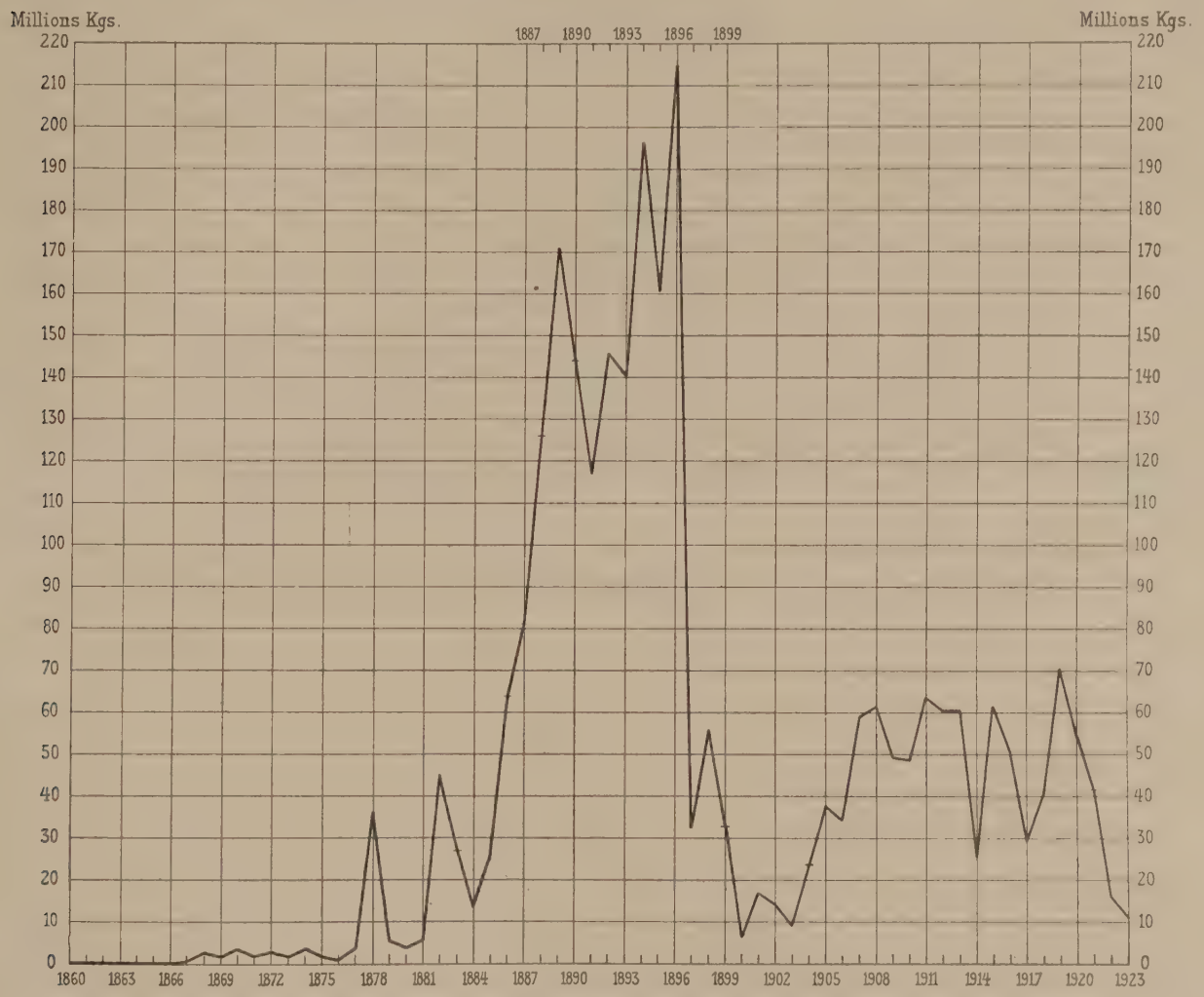

Fig. 12. The yield of the Herring Fishery from Bohuslän in the period from 1860—1923. After Otto Pettersson. In the period prior to 1897 the fishery was mainly a coast fishery. After 1904 it became mainly a fishery in the open Sea. The years 1897—1903 were a transition period.

The most important fishing apparatus in the Bohuslän Skärgård from old times were land-seines (Swedish: landvadar). Besides these drift nets and gill nets were used, e. g. during the great herring period 1887—96. According to N. Rosén (1920) the purse seine was introduced in Bohuslän in 1882, but in the beginning it played only a very subordinate rôle. At the end of the nineties of the past century, when the herring ceased to enter the Bohuslän Skärgård, the purse seine was also employed outside the Skärgård in the open sea, but it was not until motor power was introduced in the fishing vessels using the purse seine that this gear came to play a very important part. This happened in 1904, and from that

year we can date a new period in the history of the Bohuslän herring fishery. During the great herring-period from 1887—1896 the Bohuslän herring fishery was still a coast fishery. After 1904 it became mainly a fishery in the open sea. The purse seine soon became the main fishing gear, and also the herring trawl came in use.

Very different opinions have, in the course of time, been expressed as to the origin and habits of the Bohuslän Herrings. When, in the following, we shall try to elucidate this old question, we shall consider three different problems, viz.:

1) Which herring races are predominant at the present time in the open waters of the eastern Skagerak during the winter?
2) Which herring races are predominant in the coastal waters of Bohuslän (the Skärgård and fiords) in the periods of poor fishing?
3) Which herring races are dominating in the coastal waters of Bohuslän in the periods of rich fishing?

B. Which Herring Races are predominant at the present time in the open waters of the Eastern Skagerak during the Winter?

The herrings occurring in the open waters of the eastern Skagerak during winter have been subjected to racial investigations by Hj. Broch, K. A. Andersson, Molander and the author.

Under the name "Bohuslänheringe" Broch (1908) described a sample of spent herrings, of an average length of ca. 25 cm captured at Bohuslän in January 1905. The results of the analysis are not given in detail but according to some graphs and Broch's mean figures the number of vertebrae and keeled scales was as follows:

Vert. S.		Vert. præc.		K_2	
No.	Freq.	No.	Freq.	No.	Freq.
55	5	22	5	13	3
56	48	23	30	14	17
57	45	24	49	15	44
58	2	25	13	16	29
..	..	26	3	17	6
..	..	..	..	19	1
n	100		100		100
m	56.44		23.79		15.22
σ	0.62		0.84		0.97
σ_m	0.062		0.084		0.097
σ_σ	0.044		0.060		0.069

Broch maintained, on the basis of this analysis that the Bohuslän Herring belonged to a peculiar race which was closely related to the Dogger Bank Herring, but differed from this by a higher number of keeled scales (K_2). According to the information now at hand concerning the Dogger Bank Herring, (see Chap. IV) this herring has a particularly high number of keeled scales, and, in this respect, we find no difference between the Dogger Bank Herring and the sample in question. One of the samples from Dogger Bank investigated by Redeke, had even a higher average number of keeled scales (viz. 15.25) than that investigated by Broch.

K. A. Andersson (1916) and A. R. Molander (1918) are of opinion that the true "Bohuslän Winter Herring" is an autumn spawning herring, which is spawning so early in the year that the scales are formed in the very calendar year in which the hatching has taken place. They follow Heincke in the view that the "Bohuslän Winter Herring" is identical with the Jutland Bank Herring, but they are not aware that the young of the Jutland Bank Herring do not get scales in the same calendar year in which the spawning takes place (comp. Chap. IX).

Molander has tried by means of analyses of the scales to distinguish between various races of herrings caught at Skagen on March 8. 1915. He arrives at the result that there occurred two different races of autumn spawners, viz.: one with small central field in the scales, which he referred to the "Bohuslän Winter Herring", and another with large central field, which he referred to the "Kobbergrund (or Koppargrund) Herring". He found that the last harmonized with the "Kobbergrund Herrings" from the eastern Kattegat both as regard the large central field and the frequency distribution of the specimens according to the various year classes. As Dr. Molander has not investigated the number of vertebrae or fin rays etc., I consider it very doubtful whether he is right in his view. The Bank Herring of the North Sea, which according to my investigations plays a great rôle in the winter fishing of the eastern Skagerak, has also often a large central field in the scales.

When Dr. Molander includes specimens of maturity III and IV, taken on the 8. of March 1915, among the autumn spawning "Bohuslän Winter Herring" he is evidently not right. Such specimens are spring spawners.

We shall now regard the results of a series of analyses which I and my collaborators have carried out in the last decennium.

Herrings from the borders between the Kattegat and Skagerak.

In 1915 I received from Dr. K. A. Andersson a sample of fresh herrings captured by Swedish purse seine fishermen W. by S. of Vinga on February 10. 1915. Dr. Andersson stated in a letter to me (February 12. 1915) that the sample consisted of mixed herrings, and that during the Swedish fishery for the winter herring it was almost entirely such mixed herrings which had been captured, the large herrings having been extraordinarily few during the winter in question. The stage of maturity of the specimens in the sample was as follows:

ca. 1500	specimens	Maturity	I—II	(Young herrings)
- 66	—	—	III—IV	(Spring spawning herrings)
- 51	—	—	VIII	(Autumn spawning herrings).

Of the herrings of maturity I and II, 591 unsorted specimens were investigated, the lengths of which were as follows:

cm	11	12	13	14	15	16	17	18	19	20	21	22	23	24
number	2	1	5	14	10	37	88	155	103	86	54	24	10	2

The number of vertebrae was as follows:

Vert. S.		Vert. præc.		Vert. caud.	
No.	Freq.	No.	Freq.	No.	Freq.
54	3	22	5	30	4
55	15	23	148	31	40
56	181	24	270	32	180
57	263	25	128	33	244
58	119	26	36	34	110
59	10	27	3	35	13
..	..	28	1	..	..
n	591		591		591
m	56.86		24.09		32.77
σ	0.840		0.900		0.93
σ_m	0.0345		0.037		0.038
σ_σ	0.0244		0.026		0.027

This sample belongs to the Kattegat Winter Herring, which spawns in the Kattegat during winter (A. C. Johansen 1923). It differs, amongst other characters, from the North Sea Bank Herring by a higher number of vertebrae and a higher number of rays in the ventral fins.

The herrings of maturity III—IV captured south-west of Vinga on February 10. 1915 were of the following lengths:

Length cm	20	21	22	23	24	25	26	27	32	No. of spec.	Average length
♂	1	5	19	4	3	2	..	1	..	35	22.40 + 0.5
♀	..	9	7	9	3	..	2	..	1	31	22.65 + 0.5
♂ + ♀	1	14	26	13	6	2	2	1	1	66	22.52 + 0.5

The analyses showed, for the individually constant characters examined, the following distribution of the variants:

Vert. S.		Vert. præc.		Vert. caud.		K_2	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
54	1	22	3	30	2	13	9
55	9	23	13	31	12	14	33
56	37	24	27	32	27	15	18
57	11	25	19	33	20	16	4
58	4	26	2	34	3	..	..
59	2	..	..	..	..	..	..
n	64		64		64		64
m	56.22		24.06		32.16		14.27
σ	0.93		0.91		0.76		0.78
σ_m	0.117		0.114		0.095		0.097
σ_{σ}	0.082		0.081		0.067		0.069

The number of vertebrae according to the length of the herring was distributed as follows:

Number of vertebrae	Length cm 20	21	22	23	24	25	26	27	32	Σ_I
54.....	..	..	1	..	..	..	..	..	..	1
55.....	..	..	6	2	1	..	..	..	..	9
56.....	1	10	12	9	3	..	1	1	..	37
57.....	..	1	7	1	1	1	..	..	..	11
58.....	..	1	..	1	..	..	1	..	1	4
59.....	..	..	..	..	1	1	..	..	..	2
Σ_{II}.....	1	12	26	13	6	2	2	1	1	64

If we calculate the correlation coefficient, we get: $r = 0.33 \pm 0.11$.

The sample does not appear to be quite homogeneous, the larger specimens having on an average a higher number of vertebrae than the smaller ones. The majority of the specimens evidently belong to one of the local races of spring spawning herrings of the Kattegat or the southern Skagerak, but a few of the larger specimens probably belong to the Winter Herrings of the Kattegat, and a single one, much larger than the other specimens (32 cm length), is probably a Norwegian Spring Herring. It had 58 vertebrae and 14 keeled scales (K_2).

The specimens of maturity VIII, captured W. by S. of Vinga on February 10. 1915, were of the following lengths.

Length cm	17	20	21	22	23	24	25	26	27	28	29	No. of spec.	Average length
♂	1	1	3	1	2	3	3	2	5	1	..	22	24.18 + 0.5
♀	..	..	2	3	4	8	6	4	..	1	1	29	24.24 + 0.5
♂ + ♀	1	1	5	4	6	11	9	6	5	2	1	51	24.22 + 0.5

The analysis showed the following distribution of the variants for vertebrae etc.:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Ventr. fin rays	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
54	1	22	2	30	2	14	14	16	3
55	2	23	11	31	4	15	22	17	12
56	25	24	27	32	16	16	13	18	34
57	16	25	6	33	20	..	..	..	..
58	4	26	3	34	7	..	..	..	..
59	1	..	..	..	..	..	..	..	..
n	49		49		49		49		49
m	56.47		23.94		32.53		14.98		17.63
σ	0.87		0.88		0.98		0.75		0.60
σ_m	0.124		0.126		0.140		0.107		0.086
σ_σ	0.088		0.089		0.098		0.075		0.061

A comparison with the samples of the Bank Herrings of the North Sea will show that the sample at hand is in entire agreement with these. (Comp. Chap. VII).

Herrings from North of Skagen.

In the spring of 1915 I investigated a sample of herrings captured with purse seine N. of Skagen on March 17. 1915. The sample consisted of 287 specimens of the following maturity:

83	specimens	of	maturity	I and II	(Young herrings)
14	—	-	—	III—IV	(Spring spawning herrings)
190	—	-	—	VIII	(Autumn spawning herrings)

The specimens of maturity I—II were of the following lengths:

	Group A					Group B				
cm.....	19	20	21	22	23	24	20	21	22	23	24
number.....	5	13	23	27	6	2	2	0	3	1	1

The analysis gave, for the individually constant characters examined, the following results:

Herrings of maturity I and II N. of Skagen. March 17. 1915.

Group A						Group B			
Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	1	23	23	30	1	14	3	18	7
56	25	24	36	31	2	15	4	..	..
57	36	25	13	32	19	..	..	..	..
58	14	26	4	33	42	..	..	..	..
..	..	..	..	34	9	..	..	..	..
..	..	..	..	35	3	..	..	..	..
n	76		76		76		7		7
m	56.83		23.97		32.86		14.6		18.0
σ	0.73		0.83		0.86		..		..
σ_m	0.084		0.095		0.099		..		..
σ_σ	0.060		0.067		0.070		..		..

This sample, which has the same race characters as the sample mentioned on p. 63, belongs to the Kattegat Winter Herring.

The 14 specimens of maturity III and IV were of the following lengths:

cm	20	21	22	23	24	No. of spec.	Average length
♂	..	1	..	3	3	7	23.1 + 0.5
♀	1	2	1	1	2	7	22.1 + 0.5
♂ + ♀	1	3	1	4	5	14	22.6 + 0.5

The analysis of vertebrae and keeled scales etc. gave the following result:

Vert. S.		Vert. præc.		K_2		Ventr. fin rays	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
53	1	21	1	13	2	17	3
54	..	22	2	14	7	18	10
55	5	23	4	15	4	..	..
56	6	24	4	..	..	..	..
59	1	25	1	..	..	..	..
..	..	26	1	..	..	..	..
n	13		13		13		13
m	55.62		23.38		14.15		17.70

The specimens undoubtedly belong to one of the local races of spring herrings of the Kattegat. A herring spawning in Aalbæk Bay is of a similar type.

The specimens of maturity VIII had the following lengths:

cm	21	22	23	24	25	26	27	28	29	30	No. of spec.	Average length
♂	2	5	5	20	28	17	10	2	1	1	91	24.99 + 0.5
♀	..	8	8	17	25	23	15	2	..	1	99	25.07 + 0.5
♂ + ♀	2	13	13	37	53	40	25	4	1	1	190	25.03 + 0.5

The distribution of the variants in the individually constant characters examined was as follows:

Herrings of maturity VIII N. of Skagen. March 17. 1915.

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	9	22	2	31	22	13	2	16	1
56	76	23	46	32	62	14	21	17	2
57	86	24	87	33	77	15	43	18	11
58	10	25	41	34	19	16	20	..	..
..	..	26	5	35	1	17	1	..	..
n	181		181		181		87		14
m	56.54		24.01		32.53		14.97		17.71
σ	0.68		0.80		0.86		0.78		0.6
σ_m	0.051		0.059		0.064		0.084		0.16
σ_σ	0.036		0.042		0.045		0.059		0.11

If we compare this sample with the sample of Bank Herrings from Balta Sound (Shetland Isles) investigated by me (Sept. 1921) we obtain the following result:

363 Bank Herrings, Balta Sound, minus 181 Autumn Herrings from Skagen:

Diff.	Vert. S.	— 0.04	Standard	Dev. of	Diff. 0.063
	Vert. præc.	0.17	—	—	— 0.075
	Vert. caud.	+ 0.14	—	—	— 0.081
	K_2	— 0.12	—	—	— 0.096

If we compare the sample from Skagen with the Bank Herrings from the Dogger Bank area investigated by REDEKE (Aug., Sept., Oct. 1906), we obtain the following result:

65 Dogger Bank Herrings (REDEKE) minus 181 Herrings from Skagen (JOHANSEN):

Diff.	Vert. S.	— 0.06	Standard	Dev. of	Diff. 0.09
	Vert. præc.	+ 0.17	—	—	— 0.16
	Vert. caud.	— 0.24	—	—	— 0.17
	K_2	+ 0.06	—	—	— 0.13

It will be seen that we have not found any essential difference between the sample from Skagen and the samples of the North Sea Bank Herring mentioned. On the other hand the sample from Skagen differs perceptibly from the Autumn Herrings of the North Eastern Kattegat by a higher number of caudal vertebrae as well as in other ways (Chap. XI). The same holds good for the sample from Vinga.

Herrings from North of Skagen. January 5. 1924.

Of a sample of herrings caught in purse seine 3 miles N. of Skagen on January 5. 1924, 514 specimens were investigated with regard to maturity. The distribution of the different stages was as follows:

360	specimens of maturity		I—II	Young herrings
39	—	-	III and IV	Spring spawners
38	—	-	IV—VI	Spring spawners and winter spawners
107	—	-	VII—VIII	Autumn spawners.

The lengths of 95 specimens of maturity I—II were as follows:

Length cm	18	19	20	21	22	23	24	25	26	27	28	No. of spec.	Average length cm
♂	..	3	6	7	16	7	9	3	..	..	..	51	22.12 + 0.5
♀	1	4	4	9	7	3	6	4	3	1	2	44	22.52 + 0.5
♂ + ♀	1	7	10	16	23	10	15	7	3	1	2	95	22.31 + 0.5

The analysis gave the following result for the characters constant for the individual:

Vert. S.		Vert. præc.		Vert. caud.		Keeled scales (K_9)		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	3	22	3	29	1	12	1	16	9
56	41	23	34	30	1	13	5	17	10
57	47	24	40	31	6	14	37	18	75
58	3	25	13	32	27	15	39	..	..
..	..	26	2	33	40	16	12	..	..
..	..	27	2	34	19	17	1	..	..
n	94		94		94		95		94
m	56.53		23.82		32.71		14.62		17.70
σ	0.64		0.94		0.97		0.85		0.64
σ_m	0.066		0.097		0.100		0.087		0.066
σ_σ	0.047		0.068		0.071		0.062		0.046

Total		Rays in anal fins branched		unbranched		Rays in dorsal fin branched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
15	4	12	3	2	2	14	11
16	18	13	19	3	84	15	46
17	29	14	33	4	9	16	36
18	33	15	33	..	..	17	2
19	11	16	7	..	..	..	..
n	95		95		95		95
m	17.31		14.23		3.07		15.31
σ	1.04		0.96		0.33		0.70
σ_m	0.107		0.099		0.034		0.072
σ_σ	0.076		0.070		0.024		0.051

This sample harmonizes with the Bank Herring of the North Sea (Comp. Chap. VII) although the number of keeled scales is rather low. If we compare the figures found with those observed in the Bank Herring

from Balta Sound, Sept. 1. 1921 (p. 8), we notice a difference of 0.23 with a standard deviation of the difference of 0.10.

The lengths of 39 specimens of maturity III—IV were as follows:

Length cm	19	20	21	22	23	24	25	26	No. of spec.	Average length cm
♂	..	2	..	1	2	1	1	..	7	22.78 + 0.5
♀	1	..	9	6	7	2	2	5	32	22.43 + 0.5
♂ + ♀	1	2	9	7	9	3	3	5	39	22.72 + 0.5

The distribution of the variants for vertebrae, and keeled scales etc. was as follows:

Vert. S.		Vert. præc.		Vert. caud.		Keeled scales K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
54	3	21	1	29	1	13	3	18	38
55	11	22	8	31	4	14	24	19	1
56	12	23	12	32	16	15	11	..	..
57	12	24	12	33	10	16	1	..	..
58	1	25	5	34	6	..	..	..	..
..	..	26	1	35	2	..	..	..	..
n	39		39		39		39		39
m	55.92		23.38		32.54		14.26		18.03
σ	1.01		1.115		1.19		0.64		0.16
σ_m	0.16		0.18		0.19		0.10		0.03
σ_σ	0.11		0.13		0.135		0.07		0.02

Total		Rays in anal fin branched		unbranched		Rays in dorsal fin branched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
14	1	11	1	3	32	13	1
15	3	12	3	4	5	14	7
16	6	13	6	..	..	15	25
17	10	14	11	..	..	16	6
18	13	15	16	..	..	..	..
19	4	..	..	..	..	..	..
n	37		37		37		39
m	17.16		14.03		3.14		14.92
σ	1.24		1.11		0.35		0.66
σ_m	0.20		0.18		0.06		0.11
σ_σ	0.14		0.13		0.04		0.075

The sample belongs to one of the local races of spring spawners of the Kattegat and the southern Skagerak.

The lengths of 38 specimens of maturity IV—VI were as follows:

Length cm	20	21	22	23	24	25	26	27	No. of spec.	Average length cm
♂	1	5	9	11	4	3	2	1	36	22.9 + 0.5
♀	..	..	..	..	..	..	2	..	2	26.0 + 0.5
♂ + ♀	1	5	9	11	4	3	4	1	38	23.1 + 0.5

It will be noticed that almost all the specimens were males. If we regard the length of the specimens in proportion to the total number of vertebrae and the total number of anal fin rays, it will be seen that the larger specimens have a higher number of vertebrae and of anal fin rays than the smaller ones:

Correlation between length and total number of vertebrae in specimens of maturity IV—VI.

Length cm / Vert. S.	20	21	22	23	24	25	26	27	Σ_I
53	..	2	..	..	..	..	..	..	2
54	..	..	1	1	1	..	..	..	3
55	1	3	4	1	1	..	..	..	10
56	..	..	3	8	..	1	..	..	12
57	..	..	1	1	1	2	3	..	8
58	..	..	..	..	1	..	1	1	3
Σ_{II}	1	5	9	11	4	3	4	1	38

$r = 0.66 \pm 0.09$.

Correlation between length and total number of anal fin rays in specimens of maturity IV—VI.

Length cm / Anal rays	20	21	22	23	24	25	26	27	Σ_I
15	1	1	1	1	..	..	..	..	4
16	..	3	3	3	1	..	..	..	10
17	..	..	1	1	2	1	1	..	6
18	..	1	4	4	..	1	1	1	12
19	..	..	..	2	1	1	1	..	5
20	..	..	..	..	..	..	1	..	1
Σ_{II}	1	5	9	11	4	3	4	1	38

$r = 0.44 \pm 0.13$

If we divide the sample into two groups according to length, it appears that the specimens of 20—24 cm length harmonize with the spring spawners of maturity III—IV mentioned above, while the specimens of 25—27 cm length in all probability belong to the Winter Herrings of the Kattegat (comp. A. C. Johansen, 1923).

Length cm	No. of spec.	Vert. S.	Vert. præc.	Vert. caud.	Keeled scales K_2	Rays in ventral fins	Rays in anal fin total	Branched rays in dorsal fin
20—24	30	55.43	23.33	32.10	14.13	17.90	16.90	14.87
25—27	8	57.13	24.13	33.00	14.38	18.00	18.25	15.13

The lengths of 107 specimens of maturity VII—VIII were as follows:

Length cm	20	21	22	23	24	25	26	27	28	29	No. of spec.	Average length cm
♂	2	1	2	6	8	7	8	12	7	1	54	$25.31 + 0.5$
♀	..	1	4	11	5	10	7	9	2	4	53	$25.08 + 0.5$
♂ + ♀	2	2	6	17	13	17	15	21	9	5	107	$25.20 + 0.5$

The distribution of the variants for the individually constant characters examined is given below:

Vert. S.		Vert. præc.		Vert. caud.		Keeled scales K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	9	22	1	30	8	12	2	14	1
56	42	23	30	31	9	13	5	15	1
57	50	24	49	32	33	14	23	16	18
58	5	25	19	33	40	15	49	17	11
59	1	26	8	34	15	16	25	18	75
..	..	..	..	35	2	17	3	20	1
n	107		107		107		107		107
m	56.50		24.03		32.48		14.93		17.50
σ	0.76		0.90		1.11		0.96		1.00
σ_m	0.073		0.087		0.107		0.093		0.097
σ_0	0.052		0.061		0.076		0.066		0.068

Total		Rays in anal fin branched		unbranched		Rays in dorsal fin branched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
15	3	12	3	2	6	14	9
16	19	13	18	3	90	15	57
17	31	14	34	4	9	16	37
18	36	15	37	..	..	17	2
19	15	16	11	..	..	..	..
20	1	17	2	..	..	..	..
n	105		105		105		105
m	17.42		14.39		3.03		15.30
σ	1.06		1.05		0.38		0.66
σ_m	0.104		0.103		0.037		0.064
σ_o	0.073		0.073		0.026		0.046

It will be seen that this sample harmonizes with the Bank Herring of the North Sea (comp. Chap. VII). The number of rays in the ventral fins is unusually low, but it should be noted that the mean error of the mean value is as high as 0.10. In the Bank Herring the average number of rays in the ventral fins lies usually between 17.65 and 17.85.

Herrings from N.W. of Skagen. January 26. 1924.

A sample of Herrings of 410 specimens caught in purse seine North West of Skagen on January 26. 1924, contained:

102	herrings of maturity	I and II	Young herrings
42	— - —	III and IV	Spring spawners
16	— - —	IV—VI	Spring spawners and winter spawners
150	— - —	VII—VIII	Autumn spawners
100	— - —	VIII	Autumn spawners

The specimens of maturity I—V were not investigated for any other character but maturity.[1] The autumn spawners were divided in two groups according to the state of maturity and the fat contents. The group consisting of 150 specimens of maturity VII—VIII had evidently spawned later in the season than the other group of maturity VIII. The first named group consisted of meagre specimens with no fat observable in the ventral cavity, while the second group of maturity VIII had some fat on the intestines (fat contents + or 1 according to Hjort's scale). The lengths of the specimens of maturity VII—VIII were as follows:

Length cm	21	22	23	24	25	26	27	28	29	30	32	34	No. of spec.	Average length cm
Number ♂+♀	8	6	13	18	31	22	30	17	2	1	1	1	150	25.45 + 0.5

The distribution of the variants for the individually constant characters examined was as follows:

Vert. S.		Vert. præc.		Vert. caud.		Keeled scales K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	10	22	8	30	2	13	5	15	1
56	72	23	46	31	8	14	32	16	20
57	52	24	63	32	44	15	78	17	19
58	3	25	17	33	68	16	35	18	106
..	..	26	3	34	14	..	..	19	1
..	..	..	..	35	1	..	..	..	..
n	137		137		137		150		147
m	56.35		23.72		32.63		14.95		17.58
σ	0.648		0.840		0.830		0.763		0.757
σ_m	0.055		0.072		0.071		0.062		0.062
σ_o	0.039		0.051		0.050		0.044		0.044

[1] The sample taken North of Skagen on January 5. 1924 contained also specimens of maturity I—VI. These specimens were subjected to a closer examination (comp. p. 67).

The sample was evidently not quite homogeneous. If we calculate the correlation between length and Vert. S. and length and K_2, we obtain the following result:

Length cm	21	22	23	24	25	26	27	28	29	30	32	34	Σ_I
Vert. S.													
55	2	2	2	..	1	2	..	1	..	..	..	..	10
56	3	2	5	10	16	10	13	9	1	1	1	1	72
57	..	1	2	5	11	9	16	7	1	..	..	..	52
58	..	..	..	..	1	1	1	..	..	..	..	..	3
Σ_{II}	5	5	9	15	29	22	30	17	2	1	1	1	137

$r = 0.27 \pm 0.08$

Length cm	21	22	23	24	25	26	27	28	29	30	32	34	Σ_I
K_2													
13	..	..	..	..	2	1	1	1	..	..	..	..	5
14	4	1	2	2	7	6	5	4	1	..	..	..	32
15	3	3	5	15	16	8	17	9	1	..	1	..	78
16	1	2	6	1	6	7	7	3	..	1	..	1	35
Σ_{II}	8	6	13	18	31	22	30	17	2	1	1	1	150

$r = 0.02 \pm 0.06$

It will be seen that the small specimens have a lower number of vertebrae than the larger ones, but about the same number of keeled scales. Most of the larger specimens evidently belonged to the Bank Herring of the North Sea. It is not clear whether the smaller ones belong to one of the local races of autumn spawners from the marginal areas of the North Sea or to the small autumn herring spawning in shallow water of the Northern Kattegat (see p. 49 footnote). From the survey below it will be seen that the specimens of 25 cm and above agree very closely with the Bank Herring of the North Sea.

Herrings of Maturity VII—VIII caught N.W. of Skagen on January 26. 1924. — Only specimens of 25—34 cm.

Vert. S.		Vert. præc.		Vert. caud.		Keeled scales K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	4	22	4	30	1	13	5	15	1
56	52	23	36	31	5	14	23	16	11
57	44	24	48	32	32	15	52	17	16
58	3	25	12	33	52	16	25	18	76
..	..	26	3	34	12	..	..	..	..
..	..	..	..	35	1	..	..	..	..
n	103		103		103		105		104
m	56.45		23.75		32.70		14.92		17.61
σ	0.62		0.83		0.54		0.81		0.72
σ_m	0.061		0.081		0.053		0.079		0.070
σ_a	0.043		0.057		0.037		0.056		0.050

The lengths of the specimens of maturity VIII were as follows:

Length cm	22	23	24	25	26	27	28	29	No. of spec.	Average length cm
♂ + ♀	1	6	26	29	12	19	2	5	100	$25.35 + 0.5$

The distribution of the variants for the individually constant characters examined was as follows:

Vert. S.		Vert. præc.		Vert. caud.		Keeled scales K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	5	22	7	30	3	13	10	15	1
56	53	23	37	31	7	14	31	16	13
57	39	24	40	32	24	15	42	17	10
58	2	25	13	33	46	16	16	18	74
..	..	26	2	34	18	17	1	..	..
..	..	..	..	35	1	..	..	..	..
n	99		99		99		100		98

m	56.38	23.66	32.73	14.67	17.60
σ	0.618	0.871	0.978	0.900	0.753
σ_m	0.062	0.088	0.098	0.090	0.076
σ_σ	0.044	0.062	0.069	0.064	0.054

Total		Rays in anal fin branched		unbranched		Rays in dorsal fin branched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
14	1	11	1	3	78	13	1
15	1	12	2	4	13	14	9
16	13	13	16	..	..	15	50
17	34	14	36	..	..	16	39
18	37	15	33	..	..	..	..
19	5	16	3	..	..	..	..
n	91		91		91		99
m	17.32		14.18		3.14		15.28
σ	0.906		0.914		0.352		0.671
σ_m	0.095		0.096		0.037		0.067
σ_σ	0.067		0.068		0.026		0.048

There seems no reason to believe that the sample should not be homogeneous. If we calculate the correlation between length and number of vertebrae (Vert. S.), we obtain the correlation coefficient $r = -0.06 \pm 0.10$.

The sample belongs evidently to the Bank Herring of the North Sea, but it is noteworthy that it has a lower number of keeled scales than the other autumn spawners taken in the same catch. In all probability the Bank Herrings of maturity VII—VIII originate from the Dogger Bank area, while the specimens of maturity VIII come from a more northern part of the North Sea, where the spawning takes place at an earlier date than in the Dogger Bank area.

Also if we regard the distribution of the various year classes, there appears to be a difference between the two groups. From the survey below it will be seen that the sample of maturity VII—VIII contains proportionately many more specimens with 7 winter rings than the specimens of maturity VIII. The specimens with 3 winter rings in the sample of maturity VII—VIII probably do not belong to the Bank Herring of the North Sea.

Age and Length of herrings of maturity VII—VIII caught in purse seine N.W. of Skagen on January 26. 1924.

Length cm / No. of winter rings	21	22	23	24	25	26	27	28	29	30	32	34	Total No. of spec.	Average length cm	+ 0.5
3	4	3	2	..	..	..	..	..	..	..	..	..	9	21.78	22.28
4	4	1	7	4	1	2	1	..	..	..	..	..	20	23.35	23.85
5	..	2	4	10	15	6	3	..	..	..	..	..	40	24.70	25.20
6	..	..	..	3	9	6	8	2	..	..	..	..	28	25.89	26.39
7	..	..	..	1	3	3	12	3	1	..	1	..	24	26.92	27.42
8	..	..	..	..	..	4	3	8	..	..	..	..	15	27.27	27.77
9	..	..	..	..	..	..	2	1	..	1	..	..	4	28.00	28.50
10	..	..	..	..	..	..	..	..	1	..	..	..	1	29.00	29.50
11	..	..	..	..	..	..	..	1	..	..	..	..	1	28.00	28.50
4—5	..	..	..	..	1	..	..	..	..	..	..	..	1	..	..
?	..	..	..	..	2	1	1	2	..	..	..	1	7	..	..
Total	8	6	13	18	31	22	30	17	2	1	1	1	150	..	..

Age and length of specimens of maturity VIII caught in purse seine N.W. of Skagen on January 26. 1924.

Length cm / No. of winter rings	22	23	24	25	26	27	28	29	No. of spec.	Average length cm	+0.5
4	..	1	8	6	1	..	..	..	16	24.44	24.94
5	1	2	13	11	4	3	..	..	34	24.71	25.21
6	..	3	5	11	7	10	2	1	39	25.67	26.17
7	..	..	..	..	..	5	..	1	6	27.33	27.83
8	..	..	..	..	..	..	..	3	3	29.00	29.50
9	..	..	..	..	..	1	..	..	1	27.00	27.50
5—6	..	..	..	1	..	..	..	..	1	..	..
Total	1	6	26	29	12	19	2	5	100	..	..

It will be noted that for both samples the average length at a certain age agrees with that observed in the Bank Herring of the North Sea taken off the East Coast of England between North Shields and North Haisborough Float (comp. Table 3 p. 24).

Herrings caught N. W. of Hirshals.

A sample of herrings caught in purse seine N. W. of Hirshals at 40 fms. depth (ca. 57° 45′ N. 9° 15′ E.) on the 6. of March 1923, consisted of 561 specimens the maturity of which was as follows:

120	specimens of	Maturity	I	}	Young herrings
256	—	-	—	II	}
34	—	-	—	III	}
19	—	-	—	IV	} Spring spawning herrings
12	—	-	—	V	}
120	—	-	—	VII-VIII	Autumn spawning herrings.

The sample was caught during a period when the yield of the herring fishing in that part of the Skagerak was small.

The lengths of the 120 specimens of Maturity I were as follows:

cm	16	17	18	19	20	21	22	23	Average length
No. of specimens	2	3	16	19	22	29	24	5	20.2 + 0.5

The lengths of 146 specimens of Maturity II were as follows:

cm	17	18	19	20	21	22	23	24	No. of spec.	Average length
♂	..	..	2	9	13	28	15	2	69	21.74 + 0.5
♀	1	4	8	5	18	27	10	4	77	21.29 + 0.5
♂ + ♀	1	4	10	14	31	55	25	6	146	21.50 + 0.5

The analysis showed that the herrings of Maturity I and II had the same racial characteristics. The distribution of the variants of 266 specimens of Maturity I and II was as follows:

Herrings from N. W. of Hirshals. March 6. 1923. Maturity I—II.

Vert. S.		Vert. præc.		Vert. caud.		K_9		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	4	22	6	29	2	12	1	14	2
56	107	23	86	30	3	13	26	15	..
57	136	24	123	31	17	14	107	16	31
58	18	25	41	32	67	15	95	17	25
59	1	26	7	33	123	16	32	18	202
..	..	27	2	34	52	17	4	19	3
..	..	28	1	35	2	..	..	..	..
n	266		266		266		265		263

m	56.64	23.88	32.77	14.54	17.65
σ	0.65	0.89	0.95	0.90	0.76
σ_m	0.040	0.054	0.058	0.055	0.047
σ_σ	0.028	0.038	0.041	0.039	0.033

Rays in dorsal fin branched		Total		Rays in anal fin branched		unbranched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
13	1	16	34	13	40	2	1
14	18	17	95	14	98	3	229
15	148	18	90	15	89	4	24
16	86	19	33	16	25	..	..
17	3	20	2	17	2	..	..
n	256		254		254		254
m	15.28		17.50		14.41		3.09
σ	0.63		0.91		0.90		0.30
σ_m	0.039		0.057		0.056		0.019
σ_σ	0.028		0.040		0.040		0.013

The analysis suggests that the sample consists mainly of the North Sea Deep Water Herring, and to a smaller extent of the Bank Herring of the North Sea. We get some evidence in favour of the view that we have such a mixture before us by a calculation of the correlation between the length and

1) the total number of vertebrae
2) the number of keeled scales (K_2).

It appears from the figures below that there is probably a positive correlation between length and Vert. S., but a negative correlation between length and keeled scales. The small herrings which are mixed with the larger Deep Water Herrings have therefore a lower number of Vert. S. but a higher number of keeled scales than these. This agrees with the characters of the Bank Herring.

Correlation between length and number of Vertebrae (Vert. S.).
Herrings N.W. of Hirshals March 6. 1923.

cm / Vert. S.	16	17	18	19	20	21	22	23	24	Σ_I
55	..	..	1	2	1	..	..	..	..	4
56	..	1	12	11	18	23	29	12	1	107
57	2	3	6	15	14	36	42	14	4	136
58	..	..	1	1	3	1	7	4	1	18
59	..	..	..	..	..	..	1	..	..	1
Σ_{II}	2	4	20	29	36	60	79	30	6	266

$r = 0.157 \pm 0.060$

Correlation between Length and number of Keeled Scales (K_2).
Herrings N.W. of Hirshals, March 6. 1923.

cm / K_2	16	17	18	19	20	21	22	23	24	Σ_I
12	..	..	..	..	1	..	..	..	..	1
13	..	..	2	1	1	7	10	4	1	26
14	..	3	5	10	11	24	32	18	4	107
15	1	1	11	14	16	20	27	4	1	95
16	1	..	2	3	7	9	6	4	..	32
17	..	..	..	1	..	..	3	..	..	4
Σ_{II}	2	4	20	29	36	60	78	30	6	265

$r = -0.162 \pm 0.060$

The lengths of the specimens of Maturity III—V were as follows:

Length cm	19	20	21	22	23	24	No. of spec.	Average length
♂	1	4	10	10	9	4	38	21.89 + 0.5
♀	..	..	6	8	10	3	27	22.37 + 0.5
♂ + ♀	1	4	16	18	19	7	65	22.09 + 0.5

The specimens of maturity III, IV and V had a uniform racial stamp. The distribution of the variants was as follows:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
54	4	22	4	30	2	13	17	15	1
55	11	23	23	31	7	14	29	16	1
56	24	24	22	32	25	15	18	17	2
57	18	25	14	33	24	16	1	18	60
58	8	26	2	34	6	..	..	..	..
..	..	..	..	35	1	..	..	..	..
n	65		65		65		65		64
m	56.23		23.80		32.43		14.05		17.89
σ	1.07		0.96		0.97		0.78		0.48
σ_m	0.13		0.12		0.12		0.10		0.06
σ_σ	0.09		0.08		0.08		0.07		0.04

Rays in dorsal fin				Rays in anal fin			
branched		Total		branched		unbranched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
14	7	15	2	12	2	2	1
15	12	16	9	13	13	3	49
16	43	17	26	14	29	4	14
..	..	18	22	15	17	..	..
..	..	19	5	16	3	..	..
n	62		64		64		64
m	15.58		17.30		14.09		3.20
a	0.69		0.92		0.89		0.44
σ_m	0.09		0.12		0.11		0.06
σ_σ	0.06		0.08		0.08		0.04

The results of the analyses show that we are here concerned with one of the local races of small spring herrings spawning in the Kattegat or the southern Skagerak (comp. A. C. Johansen 1919 and 1923.)

The lengths of 120 specimens of Maturity VIII were as follows:

cm	♂	♀	♂ + ♀
20	1	1	2
21	6	3	9
22	11	9	20
23	13	9	22
24	10	9	19
25	8	7	15
26	12	6	18
27	2	8	10
28	1	2	3
29	1	1	2
n	65	55	120
m[1]	24.35	24.79	24.55

[1] Corrected by adding 0.5.

We notice here that the average length of the specimens is a little smaller than is usually the case in the mature Dogger Bank Herring.

The distribution of the variants for the individually constant characters was as follows:

Vert. S.		Vert. præc.		Vert. caud.		K_2	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
54	1	22	8	29	1	13	3
55	8	23	43	30	1	14	30
56	64	24	55	31	6	15	61
57	44	25	11	32	39	16	20
58	3	26	2	33	56	17	5
..	..	..	..	34	16	..	..
..	..	28	1	35	1	..	..
n	120		120		120		119
m	56.33		23.66		32.67		14.95
σ	0.68		0.90		0.89		0.83
σ_m	0.062		0.083		0.081		0.076
σ_σ	0.044		0.058		0.058		0.054

Rays in ventral fins		Rays in dorsal fin branched		Total		Rays in anal fin branched		unbranched	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
14	1	13	1	15	3	12	5	2	3
15	1	14	13	16	30	13	28	3	103
16	15	15	60	17	46	14	50	4	9
17	9	16	39	18	29	15	25	..	..
18	91	17	3	19	5	16	5	..	..
19	3	..	..	20	2	17	2	..	..
n	120		116		115		115		115
m	17.64		15.26		17.08		14.03		3.05
σ	0.83		0.72		0.97		0.99		0.32
σ_m	0.076		0.067		0.091		0.092		0.030
σ_σ	0.053		0.048		0.064		0.065		0.021

If we calculate the correlation between length and number of vertebrae, and length and number of keeled scales, we obtain the following results:

Length cm	20	21	22	23	24	25	26	27	28	29	Σ_I
Vert. S.											
54	..	..	..	..	1	..	..	..	..	..	1
55	..	2	3	1	..	1	1	..	..	..	8
56	1	3	10	12	12	8	10	5	2	1	64
57	1	4	7	7	6	6	6	5	1	1	44
58	..	..	..	2	..	..	1	..	..	..	3
Σ_{II}	2	9	20	22	19	15	18	10	3	2	120

$r = 0.08 \pm 0.09$

Length cm	20	21	22	23	24	25	26	27	28	29	Σ_I
K_2											
13	..	..	..	1	1	..	1	..	..	..	3
14	1	1	7	3	5	5	3	2	1	2	30
15	1	5	7	11	12	9	10	4	2	..	61
16	..	3	3	6	1	1	3	3	..	..	20
17	..	..	2	1	..	..	1	1	..	..	5
Σ_{II}	2	9	19	22	19	15	18	10	3	2	119

$r = -0.07 \pm 0.09$

It will be seen that the small specimens have practically the same number of vertebrae and of keeled scales as the larger ones.

The sample of autumn spawners of maturity VIII from Hirshals has not a higher number of vertebrae (Vert. S.) than two of the samples of "Kobbergrund Herrings" mentioned in Chap. XI, but if we compare the two groups of samples, we find that the sample from Hirshals has a higher number of caudal vertebrae and of keeled scales than the "Kobbergrund Herrings":

120 Autumn Herrings from N.W. of Hirshals (March 6. 1923) minus 178 Kobbergrund Herrings (October 23. 1915).

Diff.	Vert. S.	— 0.02	Standard	Dev.	of Diff.	0.08
—	Vert. præc.	— 0.91	—	—	—	0.12
—	Vert. caud.	0.89	—	—	—	0.12
—	K_2	0.33	—	—	—	0.10
—	Rays in ventr. fins	0.26	—	—	—	0.10

If we compare the sample of autumn herrings of maturity VIII from Hirshals with the sample of Bank Herrings from Balta Sound, Sept. 1. 1921, we get the following result:

363 Bank Herrings, Balta Sound, minus 120 Autumn Herrings, Hirshals.

Diff.	Vert. S.	0.17	Standard	Dev.	of Diff.	0.073
—	Vert. præc.	0.18	—	—	—	0.095
—	Vert. caud.	0.00	—	—	—	0.095
—	K_2	— 0.10	—	—	—	0.089
—	branch. dorsal fin rays	— 0.16	—	—	—	0.076
—	total anal fin rays	0.03	—	—	—	0.104
—	branched anal fin rays	0.02	—	—	—	0.104
—	unbranched anal fin rays	0.01	—	—	—	0.038
—	ventral fin rays	0.09	—	—	—	0.084

It will be seen that the difference is greatest for the total number of vertebrae, where it is more than twice the standard deviation of the difference.

Comparing the sample of herrings of maturity VIII from Hirshals with a sample of small ripe autumn spawners of 20—26 cm length caught in the Lim Fiord off Lemvig on October 16. 1915, we obtain the following result:

171 Autumn Herrings, Lim Fiord, minus 120 Autumn Herrings, Hirshals.

Diff.	Vert. S.	0.04	Standard	Dev.	of Diff.	0.08
—	Vert. præc.	0.27	—	—	—	0.11
—	Vert. caud.	— 0.23	—	—	—	0.11
—	K_2	— 0.11	—	—	—	0.10
—	ventral fin rays	— 0.08	—	—	—	0.10

We notice here in the case of vert. præc. and vert. caud. a difference of more than twice the standard deviation of the difference.

There can be no doubt that the sample belongs either to the Bank Herring of the North Sea or to one of the local races of small autumn spawners from the marginal areas of the North Sea (the German Bight, the Lim Fiord etc.).

As the sample from Hirshals has a relatively high number of caudal vertebrae, the first possibility seems the more probable.[1]

If we regard the evidence set forth on the preceding pages it appears that the Bank Herring of the North Sea is the most important of the races upon which the great Bohuslän winter fishing is based in the open waters of the eastern and southern Skagerak at the present time. Also other races play a certain rôle for the fishery, such as the local spring spawners of the Kattegat and southern Skagerak, and the Winter Herrings of the Kattegat.

C. Which Herring Races are predominant in the Skärgård and Fiords of Bohuslän during the periods of poor fishing?

Axel Boeck (1870) who investigated the Bohuslän herrings in the period about 1870, says that the main part of the herrings were spring spawners, and v. Yhlen confirmed that the same had been the case for a series of years prior to 1870.

Ljungman (1879) maintained in his paper "Om sillens och skarpsillens fortplantning och tiltväxt" that the herrings spawning in the Bohuslän Skärgård were spring spawners, and that the importance of these had been underestimated formerly. He was of opinion that also the large winter or spring spawners which mainly occurred in the northern skärgård, belonged to the same race as the smaller ones, although — as he states — the spawning occurred earlier for the large ones than for the smaller ones.[2] He writes as follows about the autumn spawners (p. 197): "Besides the herring which usually are spawning in the skärgård or near to the coast, there seems in several places to occur another herring which spawns as a rule in the open sea on suitable banks, which are situated at such depths that they are protected against devastation from the strong waves, and it is an old supposition that the herring which, during rather long periods for the sake of spawning visits certain parts of the west coast of Scandinavia, during the intervening periods are spawning on such banks in the North Sea".

There is no reason to doubt that Boeck, v. Yhlen and Ljungman were right in their view that the main part of the herrings occurring in the coastal region of Bohuslän in poor herring periods are winter and spring spawners. In this connection it should be remembered that I have found a sample taken W. by S. of Vinga in a poor herring period in February of 1915 containing 93% of winter spawners, 4% of spring spawners and only 3% of autumn spawners. The winter spawners belonged to the Winter Herrings of the Kattegat, and the spring spawners to one of the local races spawning in the Kattegat or the southern Skagerak.

[1] Knut Dahl (1909) investigated a sample of 110 spent herrings caught in drift nets in the Skagerak near the coasts of Norway on the 4th of March 1907 together with Norwegian Spring Herrings. The mean figures obtained for Vert. S. and Vert. præc. were 56.55 and 23.89, respectively. These figures are quite in agreement with those of the Bank Herring of the North Sea.

A sample of young herrings of 8—11 cm length captured at the beach E. of Hanstholm at Lild Strand (57°09′ N. 8°57′ E.) on August 23. 1921, also belonged probably to the Bank Herring of the North Sea.

The distribution of the variants for the individually constant characters examined was as follows:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
55	1	22	3	32	7	13	1	15	1
56	9	23	4	33	5	14	6	16	1
57	6	24	8	34	3	15	6	17	1
..	..	25	1	35	1	16	2	18	13
n	16		16		16		15		16
m	56.31		23.44		32.88		14.60		17.62

[2] There can hardly be any doubt that the large winter- or spring spawners mentioned by Ljungman belonged to the Norwegian Spring Herring.

Trybom (1882) has described samples of spring spawners from the fiords of Bohuslän, and it is clear from his description that some of them belonged to the Norwegian Spring Herring (see Section D), while the main part were smaller forms and had a somewhat later spawning season. These smaller spring herrings are partly spawning in the fiords of Bohuslän.

Heincke (1898) describes 25 specimens of such local spring spawners from Bohuslän taken on April 15. 1878. The specimens were of maturity IV—VI and their lengths were as follows:

Length cm.....	18	19	20	22	24	25	26	27	28	No. of spec.	Average length
No. of spec.....	1	3	2	3	8	4	2	1	1	25	23.80 + 0.5

The distribution of the variants for the individually constant characters examined was as follows:

Vert. S.		Vert. præc.		Vert. caud.		Keeled scales K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
56	12	23	3	30	1	12	2	17	2
57	12	24	11	31	7	13	5	18	23
58	1	25	6	32	8	14	14	..	..
..	..	26	4	33	9	15	4	..	..
..	..	27	1	..	..	..	..	..	..
n	25		25		25		25		25
m	56.56		24.56		32.00		13.80		17.92
σ	0.58		1.04		0.91		0.82		0.28
σ_m	0.12		0.21		0.18		0.16		0.06
σ_σ	0.08		0.15		0.13		0.12		0.04

Rays in dorsal fin total		Rays in anal fin total	
No.	Freq.	No.	Freq.
17	3	14	1
18	20	..	..
19	2	16	4
..	..	17	13
..	..	18	6
..	..	19	1
n	25		25
m	17.96		17.04
σ	0.45		0.98
σ_m	0.09		0.20
σ_σ	0.06		0.14

It will be seen that this herring has a distinctly lower number of vertebrae than the Norwegian Spring Herring.

D. Which Herring Races are predominant in the Skärgård and Fiords of Bohuslän during the periods of rich fishing.

Axel Boeck (1870) maintains that there is a series of statements and sayings to show that the main part of the herrings caught in the great herring period from 1748 to 1808 were autumn spawners, and A. W. Ljungman (1879(b)) agrees with him in this view.

Trybom (1882) has, in his paper on the herring-fishing in Bohuslän during the winters 1880—81 and 1881—82, described about twenty small samples of herrings taken in the coastal area of Bohuslän in

the months December and January of the period named above. By investigations of the sexual organs he found the following relative frequency of spring spawners and autumn spawners:

	Autumn spawners %	Spring spawners %
Herrings caught in drift nets	57	43
— — land seines	88	12

Trybom does not attempt to show to which races the spring spawners belong, but his examinations were so careful that it is possible to say with great certainty that the main part of them belonged to the local coast herrings of the southern Skagerak and a not inconsiderable part of them to the Norwegian Spring Herring. The last was for example the case with a selected sample taken in mackerel-nets in Dynnekilen on January 14. 1880. The lengths of 10 specimens were as follows:

Length cm	32	33	34	35	36
No. of spec.	3	2	1	3	1

These specimens were of maturity V. The eggs had a diameter of 1.1—1.35 mm, and the testes were white and had a breadth of 25—37 mm. The spring spawning herrings in the fiords of Bohuslän have a smaller size and less developed sexual organs at that time of the year.

Heincke has in "Naturgeschichte des Herings" (1898) described a small sample of the Bohuslän hafssill which was captured in January 1878, and originated "from the first great shoal, which has visited the Bohuslän coasts since the year 1808". Only about 20 specimens of lengths from 22.3 to 27.8 mm were investigated.

Most of the specimens were probably recovering spents of an autumn spawning herring, but it cannot be determined whether the question concerns the autumn herrings of the North Eastern Kattegat or the autumn herrings of the North Sea. The average number of vertebrae and of keeled scales etc. found in specimens of maturity II and VII—VIII was as follows:

Vert. S.	= 56.50 (12 spec.)
K_2	= 14.35 (17 spec.)
Rays in ventr. fins	= 17.89 (9 spec.)

The sample also included a few spring spawners belonging to a smaller form than the Norwegian Spring Herring (probably one of the local races of the southern Skagerak).

An other sample investigated by Heincke originated from Marstrand, January 1891. It is mentioned by Heincke as Hafssill (Swedish) or Seeheringe (German). The sample consisted of 50 specimens of the following maturity and lengths.

Maturity	I	2	specimens	219, 273 mm
—	II	15	—	227—284 -
—	II a (VIII)	31	—	244—300 -
—	?	2	—	256, 258 -

The analysis of the specimens of maturity II showed the following distribution of the variants for vertebrae etc.:

Vert. S.		K_2		Ventral fin rays	
No.	Freq.	No.	Freq.	No.	Freq.
56	4	14	5	16	1
57	10	15	7	17	2
58	1	16	3	18	12
n	15		15		15
m	56.80		14.87		17.73

The analysis of the specimens of maturity II_a (my stage VIII) gave the following result:

Vert. S.		K_2		Ventral fin rays	
No.	Freq.	No.	Freq.	No.	Freq.
56	15	13	2	17	4
57	15	14	12	18	26
58	1	15	11	19	1
..	..	16	5	..	..
..	..	17	1	..	..
n	31		31		31
m	56.55		14.71		17.90
σ	0.57		0.94		0.40
σ_m	0.10		0.17		0.07
σ_σ	0.07		0.12		0.05

Without doubt the latter group is composed of autumn spawning herrings, which agree entirely with the Bank Herring of the North Sea. The racial characteristics of the few specimens of maturity II cannot be determined with certainty; the probability is however, that the main part ot these also belong to the Bank Herring. If we combine both groups, including two specimens of doubtful maturity, we obtain the following survey:

48 "Hafssill" from Marstrand. Jan. 1891, (Heincke):

Vert. S.		K_2		Rays in ventral fins	
No.	Freq.	No.	Freq.	No.	Freq.
56	21	13	3	16	1
57	25	14	17	17	6
58	2	15	19	18	40
..	..	16	8	19	1
..	..	17	1	..	..
n	48		48		48
m	56.60		14.73		17.85
σ	0.57		0.89		0.46
σ_m	0.08		0.129		0.066
σ_σ	0.06		0.091		0.047

It must be regarded as very fortunate that Heincke and Trybom have investigated samples of the Bohuslän herrings during the last great herring period. From the results of their researches combined with the results of my investigations of Bohuslän herrings taken in the open waters of the eastern Skagerak during the last decennium, it seems fairly clear that it is the Bank Herring of the North Sea which has been the dominating race in the inshore waters of Bohuslän during the last great herring period from 1878 to 1896. As both Axel Boeck and A. W. Ljungman on the basis of a series of old statements substantiate that the herrings caught in the penultimate herring period from 1748—1808 were autumn spawners, the probability is that the Bank Herring of the North Sea has also in times past been responsible for "the great herring periods" off the coasts of Bohuslän.

E. General Survey of the "foreign" Herring Races occurring in the Eastern and Southern Skagerak during the Winter.

In the sections B., C. and D of this Chapter we have seen that in the eastern and southern Skagerak several race groups of herrings occur which are not indigenous to this area, viz.:

1) The Bank Herring of the North Sea.
2) The North Sea Deep Water Herring.
3) The Norwegian Spring Herring.
4) The Winter Spawning Herrings of the Kattegat.

5) Spring spawners of the Kattegat.

6) Autumn spawners of the Kattegat.

According to the evidence to hand it appears that the Bank Herring of the North Sea is the most important of these races for the great winter fishing in the named area, indeed more important than all the other races together, including also the spring spawners which are in-

Fig. 13. Average No. of Keeled Scales (K_2) observed in Summer- and Autumn-Spawning Herrings of the North Sea (with mean error). B., H., J., R. indicate Name of the Investigators (Broch, Heincke, Johansen, Redeke). The Roman numerals represent the stage of Maturity.

digenous to the southern and eastern Skagerak. The question now arises: Which group of the Bank Herrings of the North Sea yields the greatest contribution to the great invasion or inflow into the Skagerak?

Of the various groups of Bank Herrings of the North Sea, the Jutland Bank Herring has its spawning places nearest to the area where the Bohuslän Herrings are caught, and it would therefore *a priori* seems probable that this group was responsible for the greatest part of the invasion. There is, however, no evidence in favour of the view that the Jutland Bank Herring should consist of such enormous shoals of herrings as those upon which the Bohuslän fishermen base their winter fishing. Moreover, it should be noted that most of the analysed samples of Bank Herrings from the eastern Skagerak have had a higher number of keeled scales (K_2) than is known

in any of the samples of Jutland Bank Herrings and Scotch Summer Herrings hitherto investigated (see Table 9). In this respect they agree entirely with the Dogger Bank Herring. It should also be observed that a very great part of the spent Bohuslän Herrings are very meagre. They have evidently not had much time for feeding after spawning.[1] This feature would also agree better with the Dogger Bank Herring than with Northern Bank Herrings spawning on Jutland Bank, off Scotland and the Shetland Isles.

It should be added that the analyses of scales have shown that the autumn spawning Bohuslän Herrings have the same size at the same age as the Dogger Bank Herrings and the herrings spawning off the coast of Northumberland, while the Bank Herrings spawning off the northern coast of Scotland and off the Shetland Isles are larger (comp. Chap. VIII).

On Fig. 13 the number of keeled scales observed in Bank Herrings taken in the Skagerak is represented, and for comparison the corresponding figures for summer and autumn spawning herrings taken in various parts of the North Sea are put down.

There is some evidence to hand that the Scotch Summer Herring may also occur in the Skagerak. An observation of K. A. Andersson (1916) and Molander (1918) speaks in favour of the view that some of the "Bohuslän Winter Herrings" are spawning in summer and not in autumn. These authors have found in samples of "Bohuslän Winter Herrings" that the central field of the scales was extremely small. When this is the case, there is evidently no question about Jutland Bank Herrings or Dogger Bank Herrings, but probably about the Scotch Summer Herring. In this connection it should be remembered that samples belonging to the North Sea Deep Water Herring have been observed in the Skagerak, so that it is not improbable that the Scotch Summer Herring may also occur in the Skagerak.

While in this paper it has been clearly demonstrated that the Bank Herring of the North Sea is the most important of the herring races occurring in the eastern Skagerak during the winter, there is still some doubt as to the question whether the Northern Bank Herrings or the Dogger Bank Herrings are of greatest importance for the fisheries.

In one respect most of the samples of autumn spawners from the Skagerak might seem to differ a little from the Dogger Bank Herrings, viz. by a lower number of rays in the ventral fins. I suppose, however, that future investigations will show that the majority of the Dogger Bank Herrings have a lower number of rays in the ventral fins than that found in the small samples investigated by Redeke. The racial characteristics of the Jutland Bank Herring are not yet sufficiently known, so that the possibility is not excluded that the majority of these may have the same high number of keeled scales as the Dogger Bank Herrings. The evidence to hand at present is, however, in favour of the view that the Dogger Bank Herring constitutes a very great part of the huge shoals of herrings which in the beginning of winter enter the Skagerak from the North Sea.

If the view set forth here is right, great shoals of herrings are moving in an easterly direction past Hanstholm late in autumn or in the beginning of winter. These shoals have hitherto not been subjected to any fishery in the boundary area between the North Sea and the Skagerak.

The North Sea Deep Water Herring seems not to be of great importance for the fisheries in the Skagerak. It has dominated in only one of the samples investigated, viz. in that caught N.W. of Hirshals on the 6. of March 1923. The specimens of maturity I and II, which had a length of 16—24 cm, consisted mainly of that race (see the survey below). It may have been present also in some other samples (e. g. in the sample from Marstrand, January 1891 investigated by Heincke), but it has not been sufficiently numerous to be identified.

The Norwegian Winter or Spring Herring has its main spawning places off the West Coast of Norway between Flekkefjord and Aalesund, but some spawning also takes place in the northern part of the Skagerak between Cape Lindesnæs and Christiania Fiord. It is frequently taken off the

[1] As shown by Ehrenbaum (1911) the herring takes almost no planktonic food during the winter, and it is a fact that proportionately few of the Bohuslän Herrings are taken with food in their stomach.

northern coasts of Bohuslän, but farther south it becomes gradually rarer, and it plays no great rôle in the herring fishing of the southern and eastern Skagerak as a whole. In the northern Kattegat the Norwegian Spring Herring is a rare occurrence.

The Winter Spawning Herrings of the Kattegat may be present in great quantities in the south eastern Skagerak during the winter, and in poor herring periods they may be dominating in the

Table. 9 Summer and Autumn spawning Herrings from the North Sea compared with samples caught in the eastern and southern Skagerak.

Locality	Investigator	Date	Number of specimens investigated	Average length of mat. spec. cm	Maturity	Vertebrae			Keeled scales K_2	Rays in ventral fins	Rays in dorsal fin, branched	Rays in anal fin		
						Total	præc.	caud.				Total	branched	unbranched
A. Deep Water Herrings.														
Tampen ca. 61°51′ N., 0°45′ E.[1]).	Broch	13-IX-04	32	30.7	VI-VII	56.94	23.59	33.35	14.41	..	..	..	..	..
Viking Bank	—	14-X-04	60	30.65	VII	56.62	23.73	32.89	14.39	..	..	..	..	..
— —	—	27-X-04	16	30.2	VII	56.63	23.31	33.32	14.25	17.62	..	..	..	..
— —	—	1-XI-04	20	29.4	VII	56.65	23.60	33.05	14.60	17.95	..	..	..	..
40 m SE. of Fair Isle 59°14′ N., 0°38′ W.[2])	—	10-IX-04	29	28.8	VII	56.52	23.83	32.69	14.59	17.76	..	..	..	..
NW. of Hirshals (the Skagerak)[3])	Johansen	6-III-23	264	..	I-II	56.64	23.88	32.77	14.54	17.65	15.28	17.50	14.41	3.09
B. Bank Herrings.														
SE. of Balta Sound	Johansen	1-IX-21	363	28.6	III-VII	56.50	23.84	32.67	14.85	17.73	15.10	17.10	14.05	3.06
Fair Isle	Heincke	27-VI-87	75(30)	26.4	III-VII	56.45	23.63	32.63	14.80	17.91	..	..	..	..
Moray Firth	Redeke	18-VII-06	50	24.7	II-IV	56.56	23.89	32.64	14.74	17.84	..	..	..	..
Off Peterhead	Heincke	Aug. 71	24	..	IV-VI	..	..	..	14.83	17.83	..	..	..	..
Off Firth of Forth	Broch	8-IX-04	31	25.4	II-III	56.45	23.81	32.64	14.74	17.61	..	..	..	..
Jutland Bank	Heincke	12-IX-89	29	28.6	V-VII	56.55	..	..	14.54	17.72	..	..	..	..
— —	—	12-VIII-89	26	..	I-II	56.31	23.81	32.50	14.73	17.81	..	..	..	..
Dogger Bank	Broch	6-IX-04	31	25.6	II-IV	56.58	23.74	32.88	14.84	..	..	..	..	..
NW. of Dogger Bank	Redeke	3-IX-06	40	25.2	III-IV	56.50	24.28	32.23	14.90	17.83	..	..	..	..
Dogger Bank	—	11-X-06	25	26.4	III-VI	56.44	24.04	32.40	15.25	17.88	..	..	..	..
Off Marstrand (The Skagerak)	Heincke	Jan. 91	48	..	VII-VIII	56.60	..	..	14.73	17.85	..	..	..	..
Off Bohuslän —	Broch	Jan. 05	100	ca. 25	VII-VIII	56.44	23.79	32.65	15.22	..	..	..	..	..
W. by S. of Vinga —	Johansen	10-II-15	49	24.72	VIII	56.47	23.94	32.53	14.98	17.63	..	..	..	..
N. of Skagen —	—	17-III-15	181	25.5	VIII	56.54	24.01	32.53	14.97	17.71	..	..	..	..
—	—	5-I-24	95	..	I-II	56.53	23.82	32.71	14.62	17.70	15.31	17.31	14.23	3.07
— —	—	5-I-24	107	25.7	VII-VIII	56.50	24.03	32.47	14.93	17.50	15.30	17.42	14.39	3.03
NW. of Skagen —[4])	—	26-I-24	105	ca. 26	VII-VIII	56.45	23.75	32.70	..	..	..	..	..	..
— —	—	26-I-24	100	25.85	VIII	56.38	23.66	32.73	14.67	17.60	15.28	17.32	14.18	3.14
NW. of Hirshals —	—	6-III-23	120	..	VIII	56.33	23.66	32.67	14.95	17.64	15.26	17.08	14.03	3.05

[1] Contains a few spring spawners of maturity II—III.
[2] It is doubtful whether this sample belongs to the Deep Water Herring or to the Scotch Summer Herring.
[3] Contains some Bank Herrings of the North Sea.
[4] Contains small autumn spawners, possibly from the Kattegat.

catches in the boundary area between the Kattegat and the Skagerak (A. C. Johansen 1923). The specimens caught here are mostly young herrings, but some mature specimens may also be taken in this area. The spawning takes place mainly in the eastern Kattegat.

The small spring Spawners of the Kattegat are usually present in minor quantities in the herring catches during the winter in the eastern Skagerak. There is here a question about different races, and those with the highest number of vertebrae can hardly be distinguished at present from the local spring spawners of the fiords of Bohuslän.

The Autumn Herrings which are spawning in the northern Kattegat may probably also be found in the Skagerak. When the herring fishery begins in August or September in the eastern Kattegat, the main shoals are evidently coming from the North. Molander (1918) is of opinion that a sample of Herrings taken at Skagen on March 8. 1915 consisted partly of "Kobbergrund Herrings", but the evidence he gives, is rather weak.

A sample of North Sea Bank Herrings of maturity VII—VIII caught N.W. of Skagen on January 26. 1924 was mixed with some small autumn spawners, which possibly belonged to the herring spawning late in autumn in shallow water of the Northern Kattegat (comp. p. 49). These were, however, not so numerous that an identification could be made with certainty.

Heincke investigated a sample of herrings caught 28 miles N. by W. of Hanstholm on August 12. 1889 (see p. 18). In the sample a few specimens of maturity III—V and of the lengths stated below occurred:

Length in cm	19	20	21	22	23
No. of specimens	2	1	2	1	1

The distribution of the variants for vertebrae etc. was as follows:

Vert. S.		Vert. præc.		Vert. caud.		K_2		Rays in ventr. fins	
No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.
54	1	23	2	28	1	12	1	16	1
55	1	24	3	..	..	13	3	17	1
56	4	25	1	31	3	14	0	18	5
57	1	..	..	32	1	15	1	..	..
..	..	28	1	33	2	16	2	..	..
n	7		7		7		7		7
m	55.71		24.42		31.29		14.00		17.57

It appears that this small sample has a very low number of Vert. S. and of K_2 but a high number of Vert. præc. in comparison with the other autumn spawners observed in the Skagerak. It seems probable that the few small mature specimens belong to one of the local races of small autumn spawners of the Kattegat (comp. A. C. Johansen 1923).

The herring fishery in the eastern Skagerak has a pronounced periodic character, and there is reason to believe that at least the most important of the foreign herring races: the Bank Herring of the North Sea leaves in the main the Skagerak during the spring months and moves towards the West across the North Sea (comp. Fig. 15 p. 96).

F. Otto Pettersson's explanation of the Annual and the Secular Periodicity in the Bohuslän Herring Fishery.

Professor Otto Pettersson has for many years studied the current-system of the North Atlantic and the minor waters of the northern Europe in connection with the periodicity of the herring fisheries. On the basis of such studies he has put forth a series of facts, hypotheses, and suggestions which have been most valuable to biologists.

We shall here quote the views which Prof. Pettersson sets forth concerning the periodicity in the Bohuslän herring fishing in his paper: "Kosmiska orsaker till rörelserna uti hafvets och atmosfärens mellanskikt" (1922). Professor Pettersson writes as follows (p. 22):

"The annual period of inflow of Gulfstream-water from spring to autumn compels the North Sea water to flow southwards along the English coast, and eastwards towards the entrance of the Skagerak as proved by the wellknown experiments with drifting-bottles[1] by Dr. Wemyss Fulton. The herringshoals

[1] Fishery Investigations of the Ministry of Agriculture and Fisheries. Ser. I. Vol. IV, No. 4 p. 7.

of the North Sea follow the movement of the surrounding water. The English season for herring drifting begins in April and lasts till September, the Swedish season for herring drifting in the Kattegat begins later in August and lasts till October under normal conditions, The spawning season of the North Sea herring falls in the beginning of September in the western part of the North Sea (Fladen-ground) and south and east of the Fladen-ground, in the vicinity of the Doggerbank, in October.[1]

The spawning takes place late in summer when the stagnant bottom water on the N. Sea plateau with its highly reduced percentage of Oxygen (up to 60 %) has been renewed by a fresh inflow.[2] During the spawning season of the North Sea herring the inflow of northern waters through the Norwegian Channel is arrested by the flow of the Gulfstream which, as may be seen from the foregoing sections, fills the channel almost entirely with Atlantic water.

Such is the usual hydrographic regimen of the North Sea in normal years, the Atlantic water dominating in autumn and the waters of northern origin in the winter months. There exists also a secular periodicity, known since a thousand years by the fishermen of the Scandinavian countries, which consists in an increment of the inflow of the northern waters into Skagerak in autumn and winter, whereby the spawning of the Norwegian spring-herring on its usual breeding-grounds is disturbed.

This secular periodicity is caused by an alteration in the circulation of the Northern Atlantic Ocean, the inflow of water of southerly origin (Gulfstream-water) from Shetland into the Norwegian Channel and Skagerak being partly arrested during some months of the year and supplanted by an inflow of waters from the Norwegian Sea and bankwater from the coastal banks of Norway. Thereby the spawningtime and spawningplaces of the Norwegian spring-herring are removed from the west coast of Norway to the other side of the Norwegian Channel which is the habitat of the other great race of herrings of the North Atlantic".

When Professor Pettersson here says that the herring shoals of the North Sea follow the movement of the surrounding water, this is probably right for certain stages of the herring, but it is not a general feature that the herring in all stages of its life follows the current. In Chap. IX of this paper I have put forth some evidence to show that we must reckon with active migrations of the herring even from the larval stages. After the transformation the herrings very often move against the current, and it is a well known fact that the full herrings often do so.

A few examples may be mentioned here. The full Autumn Herrings of the Sound, are almost always taken when wandering towards the South, although the surface current here usually has a direction towards the North. But also in cases when the current is going south, the full herrings move in a southern direction. They strive evidently to reach the suitable spawning grounds (between Saltholm and Falsterbo etc.) and they do not seem to care about the direction of the currents. (The direction of the movements of the herring can easily be seen from the way in which the fish are sitting in the drift nets. In the Sound the nets are almost always shot in the direction West-East across the current).

In the Great Belt we notice in autumn a similar movement of the full herrings towards the South and against the prevalent currents. In the case of the Norwegian Spring Herring we see that the maturing herrings (Storsild) are caught in great quantities in the period November—February off the stretch Aalesund—Throndhjem Fiord and further north, but in the spawning season: February, March and April, the ripe herrings are caught mainly on the stretch Stavanger—Aalesund. It seems then that there must have been a great movement of the maturing herrings towards the south and against the prevalent current between the two periods.

The movements of the herrings of the North Sea can not be explained solely by means of the currents, but there are two stages in the life of the herrings in which the current undoubtedly plays a great rôle for the transport, viz. the young larval stage[3], and the stage just after spawning

[1] Über den Trawlherring by Ehrenbaum and Peters. Der Fischerbote 1922 No. 11.

[2] Über die Sauerstoff-Verhältnisse der Nordsee by Dr. Gehrke; Ann. d. Hydr. 1916 p. 190.

[3] Comp. Johs. Schmidt (1904), Bjarni Sæmundsson (1908), Redeke und van Breemen (1908), and Jespersen (1920).

(maturity VII). When the spawning is over, the herrings are very meagre and not very strong. There is a series of facts to hand to show that in that stage they are moving in the same directions as the current. The spent Autumn Herrings of the Sound are almost always caught when going north like the current. The Spring Herring of Iceland is spawning off the south coast, but after spawning it follows the Irminger Stream to the West and North of Iceland[1]. It agrees quite well with these facts that the Dogger Bank Herring and other Bank Herrings of the North Sea are caught in the Skagerak not very long after spawning. But even in the spent stage the herrings do not everywhere go with the current, as may be noticed e. g. in the Kattegat. A branch of the Jutland current bends southwards into the Kattegat (Fig. 14) and forms now the under-current in the eastern Kattegat and further south in the Belt-Sea. But the spent herrings from the North Sea do not seem to follow this current further south than to the area east of Læsö. The "Kobbergrund Herrings" and the other autumn spawners caught further south in the Kattegat and Belt Sea belong to other races than the North Sea Herrings (comp. Chap. XI). The south going salt water current becomes gradually mixed with the less saline Baltic surface current, and the North Sea herrings seem to avoid such brackish water.

Fig. 14. The main direction of the Currents in the intermediate layers (c. 30—100 m) of the Skagerak and the lower layers of the Kattegat and Belt Sea. Drawn up by Aage J. C. Jensen on the basis of observations of O. Pettersson, G. Ekman, Martin Knudsen, J. P. Jacobsen, Ruppin etc.

The way in which Professor Pettersson explains the secular periodicity in the herring fishery of the eastern Skagerak, is very interesting, but there does not seem sufficient reason for combining this explanation with the hypothesis that the spawning grounds of the Norwegian Spring Herring should be disturbed by an increase of the inflow of northern waters in the Skagerak in autumn and the beginning of winter.

Gustav Ekman and Otto Pettersson give prominence to the view that the various races of herrings are bound to a certain kind of water, characterized by its temperature, salinity, plankton etc.[2] This view is undoubtedly largely correct, but it should be remembered that it is especially during — and shortly before — the spawning period that the herrings are sensitive to the tempera-

[1] Ove Paulsen (1906) is of opinion that the main food for the herring in the Icelandic Waters, viz.: *Calanus finmarchicus*, is carried to the West and North of Iceland from the South Coast by the Irminger Current. It might be suggested that the reason why the herrings move here in the same direction as the current is the fact that they are pursuing the *Calanus*. It is not probable, however, that the Spring Herring of Iceland normally begins to feed immediately after spawning.

[2] See Pettersson och Ekman (1891); Ekman, Pettersson och Trybom (1907).

ture and salinity. Outside the spawning period they may occur in great shoals in places where the temperature and salinity differ a good deal from the conditions prevailing on the spawning grounds. The Bank Herring of the North Sea spawns for example in water with a temperature of about 9—13° C, but in February and March it occurs in great numbers in the upper and intermediate layers of the eastern Skagerak, where the temperature of the water is ca. 3—5° C. The salinity of the water on the spawning places for the Bank Herring of the North Sea is 34—35.2 ‰, but the young year classes of this herring occur in numbers in the western part of the Lim Fiord where the salinity is only about 30 ‰.

Ekman, Pettersson and Trybom maintain (1907) that the herrings have no homestead, but are, so to speak, always in the act of wandering. These authors are of the opinion, that herrings of the same origin may spawn in very different areas in different years. In opposition to this standpoint it will be worth while to recall the views of the renowned Swedish naturalist, the late Sven Nilsson. He writes in "Skandinavisk Fauna" (IV Bd. 1855 p. 506): "To the area where the fishes are born, thither do they go to spawn when they are mature". Many facts have been brought forth in favour of this view since Sven Nilsson wrote these words, e. g. in case of the Eel, the Plaice and the Flounder, and I am of opinion that the evidence to hand points in the direction that Sven Nilsson on the whole is right also in the case of the herring. There seems to be a fair uniformity among herrings spawning at the same season and on the same place in different years (see Chap. XIII).

XIII. General Remarks about the Herring Races.

In later years some evidence has been brought forth to show that even such characters as number of vertebrae, number of fin rays, and keeled scales etc., are not absolutely constant in a certain race of fishes, but are influenced to some extent by external factors. When we are trying to distinguish between different races of fish, it is of the greatest importance to have some idea to what extent the mean values for the named characters may be influenced by such factors in nature.

Some years ago I proved that different age groups of plaice caught on the same locality in the northern Kattegat often differed from each other in the average number of anal fin rays (A. C. Johansen 1910). This area is, however, a boundary area between two different races of plaice, and I explained the named phenomenon by the hypothesis that the race with the highest number of anal fin rays was more predominating in certain year classes than in others.

Johs. Schmidt (1917 (b), 1921) investigated 10 successive year classes of the same population of *Zoarces viviparus* L. from the inner part of Roskilde Fiord (Sealand). He was able to demonstrate a not inconsiderable variation from year to year in respect to three different Characters, viz. total number of vertebrae, rays in right pectoral fin, and hard rays in dorsal fin. The greatest variation observed was as follows:[1]

	Lowest value	Highest value
Vert. S.	107.667 ± 0.055	108.312 ± 0.073
Rays in right pectoral	18.960 ± 0.017	19.598 ± 0.025
Hard rays in dorsal fin	5.012 ± 0.067	6.739 ± 0.025

As a mixture of the various year classes gave, year after year, on repeated analysis, about the same average values, Dr. Schmidt substantiated that the population was highly stationary, so that the differences observed could not be ascribed to migrations.

Lea (1918) found in the autumn of 1915 that two different year classes of young herrings from the North of Norway seemed to differ as regards the total number of vertebrae. He observed that the fish of about $1^2/_3$ years old averaged 57.37 vertebrae (49 specimens), while those of $2^2/_3$ years showed an average of 57.72 (241 specimens). The difference between the two age groups in this respect was 0.35 ± 0.11,

[1] The probable error of the average (not the mean error) is stated here.

but it must be remembered that the mean error of σ in the group of 49 specimens must have been considerable (I suppose about 0.07). The very high number of Vert. S. in the 241 specimens aged $2^2/_3$ years is, however, peculiar. The mean error of the mean value is here probably not more than 0.05, and the average number of vertebrae in the Norwegian spring herring is only 57.50. Here seems to be a real proof that a certain year class may differ a little in respect to number of vertebrae from the typical racial mean value.

In the spring spawning herring of the western part of the Lim Fiord I found in the years 1915, 1916 and 1918 the following average number of vertebrae and keeled scales in mature specimens of various year classes (A. C. Johansen 1919).

Date	Locality	No. of specimens	Vert. S.	K_2
27-5-1915	Off Lemvig	270	55.73 ± 0.041	14.17 ± 0.043
8-5-1916	Off Nykøbing	143	55.73 ± 0.054	14.09 ± 0.052
31-1-1918	Thisted Bredning	135	55.85 ± 0.056	14.44 ± 0.061

There is here a real difference in the number of keeled scales between the specimens taken in 1918 and those taken in 1915 and 1916, but it is perhaps not out of the question that more than one race of spring spawners may have a homestead in the western part of the Lim Fiord. There is also a possibility that the sample from January 1918 does not belong to the herrings which are spawning in the Lim Fiord.

In comparing mature specimens of four different year classes caught off the south west coast of Iceland in 1919, I observed the following mean values (A. C. Johansen 1921 a):

Year class	No. of spec.	Vert. S.	Vert. caud.	K_2	Rays in dorsal fin	Rays in anal fin	Rays in ventr. fins
1915	60	57.07 ± 0.07	32.40 ± 0.13	13.83 ± 0.10	19.30 ± 0.07	18.23 ± 0.09	17.98 ± 0.07
1914	52	57.00 ± 0.095	32.54 ± 0.10	13.67 ± 0.09	19.21 ± 0.08	18.21 ± 0.11	18.00 ± 0.10
1912	105	56.97 ± 0.067	32.29 ± 0.11	13.40 ± 0.07	19.41 ± 0.06	18.15 ± 0.09	17.73 ± 0.07
1911	126	57.04 ± 0.062	32.25 ± 0.10	13.50 ± 0.075	19.30 ± 0.05	18.21 ± 0.07	18.01 ± 0.05

We gain the impression here that the year class of 1912 differs in several respects from the other year classes.

It will be seen that the observed differences in the average values for Vertebrae etc. for various year classes of the herring on the whole are much smaller than those found between the different races of herrings mentioned in this paper.

We shall now consider the results of some experiments which Dr. Johs. Schmidt has carried out in order to demonstrate the influence of external factors on the mean values for some characters, constant to the individual, in certain species of fish. The experiments have comprised three different species: *Zoarces viviparus* L., *Lebistes reticulatus*, Regan, and *Salmo trutta* L.

A great number of *Zoarces* were in early summer, and therefore when the sexual organs were still unripe, transplanted in large wooden boxes from one locality, where the mean salinity was about 21 $^0/_{00}$, to another, where the salinity was about 12 $^0/_{00}$ (Johs. Schmidt 1920). The temperature was somewhat higher in the last named locality, but the difference is not known. The young of the transplanted specimens had 114,8 vertebrae in mean value, whilst the mother population had only about 113 in mean value. It was not possible to decide for certain to which factor or factors the difference was due.[1]

[1] Dr. Schmidt is of opinion that the influence of salinity has been greatly overestimated. He found as a general rule that the Zoarces populations had a lower number of vertebrae in the inner parts of the fiords than in the outer parts. The salinity shows usually a gradation which corresponds strikingly to the gradation in the average number of vertebrae. But in Schmidt's opinion the gradation of the average number of vertebrae has to be interpreted not as a direct effect of the salinity or of a factor acting parallel to it, but as a result of a selection.

Lebistes reticulatus is viviparous, and the female bring forth a considerable number of young at a time. The principle on which the experiments were made, was to vary the external conditions for the same pair of parents from one period of gravidity to the other and then determine the number of dorsal fin rays in the various broods of offspring (Johs. Schmidt 1917 (b), 1919). It was found that the average number of rays was larger in offspring which had developed at high temperature than in offspring the development of which had taken place at low temperature. The brood developed at 25° C. had an average of 6.91 rays, and the brood developed at 18° C. an average of 6.25 rays. Therefore a difference in the number of dorsal fin rays of about 0.1 corresponds to a difference of 1° C.

The influence of temperature on the number of vertebrae in *Salmo trutta* was tested by letting a quantity of eggs from a single female, fertilised with the sperma from one single male, develop at three different temperatures (Johs. Schmidt 1921). The result was that the lowest number of vertebrae was produced at intermediate temperatures, the values rising both with higher and with lower temperatures.

The experiment falls into three series. In the two first the development of the ova and young took place in running water, whereas in the third case the water was still, but aerated by a constant current of atmospheric air.

The results obtained were as follows:

First Series	Temp.:	1.9° C.	mean value of vert.		58.48
—	—	6.5° -	—	—	57.70
—	—	10.4° -	—	—	57.98
Second Series	—	2.3° -	—	—	58.26
—	—	6.7° -	—	—	57.93
—	—	10.2° -	—	—	58.17
Third Series	—	1.9° -	—	—	58.52
—	—	4.0° -	—	—	58.17
—	—	7.0° -	—	—	58.38

It will be seen from these experiments that the difference in the number of vertebrae produced by a difference of 1° C. is about 0.05 to 0.15 or 0.1 in mean value.

Zoarces viviparus is surely a much more "plastic" species than the herring. The differences in number of vertebrae etc. between the different races in a certain region is much greater in Zoarces than in the herring, both in numerical value and taken in proportion to the total number of vertebrae. It seems probable also that Salmo trutta is a more plastic species than the herring. When we now remember that the temperature in the spawning places for a certain herring race hardly varies more than 2 to 4° C. from place to place or from one year to another, and when we observe that the numerical differences in the number of vertebrae, keeled scales and fin rays between different herring "races" frequently reaches a numerical value of 0.5 to 2.0 or even more, it seems probable, that we are dealing here with true races, the characteristics of which are due to heredity. It is very possible that the small differences pointed out between the Scotch Summer Herring and the Dogger Bank Herring, and between the Scotch Spring Herring and the Icelandic Summer Herring etc., are not of a hereditary nature.

B. Storrow (1920) has expressed the view that spring spawners may come from young fish born either in spring or in autumn, and autumn spawners may originate in the same way. The evidence he sets forth in favour of this view is based on a consideration of the growth made up to the formation of the first winter ring, but this is surely a very fragile basis for such a far reaching conclusion. If we in an autumn spawning herring find that the central field in the scale is relatively small, we can explain this in two different ways: Firstly, there is a possibility that the herring is hatched early in the season

e. g. in July or August, and that the scales are formed in the very calender year in which the hatching took place. Secondly, there is a possibility that the herring is hatched late in the season, (November—December) and that it had a proportionately slow growth during the whole of the first year of its life.

When we observe often in spring spawning herrings that the central field in the scales is relatively large, we have a natural explanation in the fact that many specimens reach a considerable size during the first summer of their life. If the hatching has taken place in March or April, the young herrings may have scales already in June—July. The quickest growing specimens of such spring spawners are probably much larger when the first winter ring is formed, than the slowest growing autumn spawners, which are about half a year older.

Besides the views set forth here, it should be remembered that we have no certain proof that a distinct winter ring is always formed during the first winter in which the herring is provided with scales.

A certain herring race may spawn at a different time of the year in different areas, but if we examine the herrings spawning on the same locality in spring and in autumn, we shall always observe that there are marked morphological differences between them.

It is a very noticeable fact that the average number of vertebrae in the dominating herring races of the Norwegian Sea, the North East Atlantic, the North Sea and the Baltic approximates to a whole number or a half (n or $n+0.5$).

In the Atlanto-Scandian Herring the average number is about 57.50. In my paper "On the large spring spawning Sea Herring in the North West European waters" (1919) I collected the whole material of Norwegian Spring Herrings then available, and I found that 665 specimens examined had an average number of vertebrae of 57.50 ± 0.028. In the spring spawning herrings of Iceland and the Faroes the following average numbers have been observed:

Date	Locality	No. of specimens	Average number of Vert. S.	Investigator
Sept. 1915	Off Eyjafiord	196	57.36 ± 0.051	Johansen
July 28 1900	Hornafiord	16	57.56 ± 0.20	—
Dec. 1878	Off Reykjavik	10	57.50 ± 0.17	Heincke
Sept. 10 1915	Kongshavn, the Faroes	207	57.47 ± 0.049	Johansen
April 1920	— —	160	57.33 ± 0.051	—

In the sample from Eyjafiord, Sept. 1915, the average number of vertebrae was somewhat below 57.50, but the sample probably contained some specimens of the Summer Spawning Herring of Iceland which has only 57.00 vertebrae in mean value.

In the sample from Kongshavn, April 1920, the average number of vertebrae is also somewhat below 57.50, but in this case there is a positive correlation between length and number of vertebrae (A. C. Johansen 1921 b. p. 6). It is not improbable that the sample contained specimens of the North East Atlantic Herring.

In the North East Atlantic Herring (the Scotch Spring Herring, the Icelandic Summer Herring etc.) we find that the average number of vertebrae is very nearly 57.00,[1] as will appear from the survey below:

[1] While this paper was in the press, I received a treatise of Ed. Le Danois et Henri Heldt on: "Les Harengs des Smalls et les Conditions hydrologiques de leurs migrations" (Janvier 1924). The authors show that the Herring of the Smalls differ markedly from the Channel Sea Herring, and Dr. Heldt is of opinion that when the Herrings leave the Smalls in the beginning of the winter, they migrate northwards to the East Coast and S.E. Coasts of Scotland. Dr. Heldt states that the average number of vertebrae in the Herring of the Smalls is 57.49, but it does not appear from his description how many specimens he examined in respect to number of vertebrae, or how large the mean error of the mean value is. If the mean value given by Dr. Heldt is based upon countings of a considerable number of specimens, the Herring of the Smalls has a higher number of vertebrae than both the Scotch Spring Herring and the Scotch Summer Herring.

Date	Locality	No. of specimens	Average number of Vert S.	Investigator
May 1919	Eldey Bank, S.W. Iceland	297	57.071 ± 0.038	Johansen
Aug. 14 1919	Drangar —	180	57.011 ± 0.048	-
Febr. 1892	Ballantrae S. W. Scotland	30	56.80 ± 0.14	Heincke
July 7 1891	Barra, Hebrides	30	56.97 ± 0.12	—
Jan. 1892	Firth of Forth	30	56.83 ± 0.10	—
March 5 1923	Off Cape Wrath	270	57.13 ± 0.038	Johansen
- - 21 -	N. of Flugga, Shetland Is.	300	57.07 ± 0.036	—

Table 10. Average Number of Vertebrae observed in Herring Races of Minor Importance from the North Sea and adjacent waters.

Name of Race	Locality of Capture	Time of Capture	No. of specimens examined	Maturity	Aver. number of vertebrae with mean error	Investigator
Winter Herring of western part of Channel	Off Plymouth	Dec.-Jan. 1914-15	1021	III-VI	56.77 ± 0.019	Orton
North Sea Deep Water Herring	Viking Bank, Tampen	Sept.-Nov. 1904	130	VII	56.73 ± 0.07	Broch
Spring Herring of Zuiderzee	Zuiderzee	April 1888	127	IV-VII	55.35 ± 0.068	Heincke
— — —	Marsdiep near Helder	May 1912	50	VII	54.78 ± 0.13	Delsman
— — —	Near the Island of Urk	Dec. 1912	40	III-V	55.125 ± 0.12	—
Spring Herring, Mouth of Ems	Ditzum, Dollart	May 1888	79	VI-VII	55.18 ± 0.09	Heincke
Spring Herring of Ringkøbing Fiord	Ringkøbing Fiord	April 1889	32	V-VI	55.50 ± 0.13	—
— — —	— —	— 1915	165	V-VI	55.56 ± 0.054	Johansen
Autumn Herring of Lim Fiord[1]	Nissum Bredning off Lemvig	Oct. 1915	171	V-VI	56.37 ± 0.056	—
— — - — —	— — - Gjeller Hage	Nov. 1923	37	V-VII	56.38 ± 0.11	—
— — - — —	— — - Rimmer Str.	— —	44	V-VII	56.23 ± 0.10	—
Spring Herring of Lim Fiord	Lim Fiord off Struer	April 1887	50	V-VII	55.90 ± 0.087	Heincke
- — - — —	— — - Lemvig	May 1915	270	V-VI	55.73 ± 0.041	Johansen
- - — —	— — - Nykøbing	— 1916	143	V-VII	55.73 ± 0.054	—
- - — —	— — - Hals	— 1916	210	IV-V	55.77 ± 0.042	—
- — - — —	— — - Hals	Jan. 1918	135	IV-V	55.85 ± 0.056	—
Spring Herring of Bohuslän Fiords	Coastal waters off Bohuslän	April 1878	25	IV-VI	55.56 ± 0.12	Heincke
Winter Herrings of the Kattegat	N. of Skagen	March 1915	76	I-II	56.83 ± 0.084	Johansen
— - - —	S. W. of Vinga	Febr. 1915	591	I-II	56.86 ± 0.0345	—
- — - - —	Near Kobbergrund, Kattegat	Oct. 1915	40	V	56.78 ± 0.14	—
— - - —	E. of Læsø, —	— 1922	71	IV	56.75 ± 0.100	—
— - - —	Groves Flak, —	— 1922	25	III-IV	56.84 ± 0.14	—
Spring Herring of N. E. Kattegat	S. V. of Vinga, —	Febr. 1915	64	III-V	56.22 ± 0.12	—
- — - —	N. V. of Hirshals, Skagerak	March 1923	65	III-V	56.23 ± 0.13	—
Autumn Herring of N. E. Kattegat	Off Varberg, Kattegat	Oct. 1887	67	IV-VII	56.37 ± 0.085	Heincke
— — - —	Near Kobbergrund, Læsø	Oct. 1915	178	VII	56.35 ± 0.052	Johansen
— — - —	Groves Flak, Kattegat	— 1922	400	VI	56.11 ± 0.034	—
— - —	E. of Læsø —	— 1922	120	VII	56.12 ± 0.068	—

[1] This herring race originates undoubtedly from the North Sea and has entered the Lim Fiord in the period after 1825.

In the Bank Herring of the North Sea the average number of vertebrae is very nearly 56.50, as will be seen from Chap. VII of this paper. In 803 mature Bank Herrings from various parts of the North Sea we have found an average number of 56.496 ± 0.024.

The Channel Sea Herring has also nearly 56.50 vertebrae in mean value. The figures found by the various investigators were as follows:

Date	Locality	No. of specimens	Average number of Vert. S.	Investigator
Winter 1901-02	Off Cap d'Antifer	125	56.57 ± 0.063	Cligny
Oct. 24 1910	Off Gr. Yarmouth	50	56.50 ± 0.081	Delsman
Nov. 1905	H 8 (52°35′ N. 2°30′ E.)	100	56.56 ± 0.089	Redeke
-	52°43.5′ N. 2°50′ E.	100	56.63 ± 0.073	—

The four important Herring races mentioned here, viz. the Atlanto-Scandian Herring, the North East Atlantic Herring, the Bank Herring of the North Sea and the Channel Sea Herring are responsible for about $^4/_5$ of the total yield of the European herring fisheries (which is about 1100—1200 million Kgs. pro year). All other herring races together are responsible only for about $^1/_5$ of the yield. We shall here shortly consider the average number of vertebrae in a group of these races of minor economical importance from the North Sea and the adjacent waters (Table 10).

From the figures in Table 10 we see that the average numbers of vertebrae in the races of minor importance do not usually group themselves about the whole or half numbers.

In the Baltic waters we notice a similar phenomenon. The most important race, viz. the South Baltic Autumn Herring, has nearly 55.50 vertebrae in mean value, as will be seen from the survey below.

Average number of vertebrae observed in the South Baltic Autumn Herring.

Locality of Capture	Date of capture	No. of spec. examined	Maturity	Average number of Vert. S. with mean error	Investigator
The Gotland Bank	18. Sept. 1887	35	IV-VII	55.51 ± 0.13	Heincke
N. W. of Nordpeerd, Rügen[1]	3. Oct. 1891	30	IV-VI	55.53 ± 0.10	—
Off Rönne, Bornholm	7. Oct. 1914	99	IV-VI	55.55 ± 0.065	Johansen
East of Bornholm	30. Sept. 1915	227	V-VII	55.45 ± 0.042	—
Off Rødby (S. of Laaland)	20. Oct. 1915	185	VII	55.48 ± 0.049	—
Masnedsund (S. of Sealand)[1]	5. Oct. 1915	215	V-VII	55.54 ± 0.040	—

The various races of the "Strömming" in the eastern and northern part of the Baltic have more than 55.00 but less than 55.50 vertebrae in mean value.

In the middle Kattegat autumn spawning herrings occur which have about 56.00 vertebrae in mean value. They are of considerable importance but they do not seem to have a quite uniform racial stamp. The hydrographical factors, such as temperature and salinity etc. do not appear to be sufficiently constant and uniform for the development of one single race which predominates markedly over all the others.

A spring spawning herring occurring in the western part of the Baltic has very nearly 56.00 vertebrae in mean value, as appears from the survey below:

Locality of Capture	Date of capture	No. of spec. examined	Maturity	Average number of vert.	Investigator
Prohner Wieck	11. May 1888	33	VI-VII	56.00 ± 0.12	Heincke
— —	28. May 1888	46	IV-VII	56.04 ± 0.12	—
— —	March 1891	24	IV-V	56.00 ± 0.12	—
— —	April 1891	30	IV-VII	56.17 ± 0.10	—
Guldborg Sund	3.-4. May 1916	211	V-VII	55.94 ± 0.043	Johansen

This herring does not play any great rôle at present, but it was possibly of great importance formerly when the waters in the Baltic were more saline.

There is naturally a characteristic difference in the distribution of the variants between races in which the average number of vertebrae approximates to whole numbers and races where it approximates to half numbers. In the first case it recalls the coefficients of $(a+b)^n$ where n is an even number, and in the second case the same where n is an odd number. A few examples will illustrate this:

[1] The samples from Nordpeerd and Masnedsund had a little higher number of keeled scales (K_s) than the other samples and belonged possibly to the West Baltic Herrings.

A. Herring Races whose average number of vertebrae approximates to whole numbers.

	North East Atlantic Herring		South West Baltic Spring Herring
	Drangar S.W. Iceland. Aug. 1919	All material available (see p. 51—55)	(see p. 93)
No.	Freq.	Freq.	Freq.
54	1	2	5
55	0	8	55
56	28	156	225
57	129	738	58
58	29	221	1
59	2	11	..
60	..	1	..
n	180	1137	344
m	57.011	57.060	55.985
σ	0.64	0.647	0.632
σ_m	0.048	0.019	0.034
σ_σ	0.034	0.014	0.024

B. Herring Races whose average number of vertebrae approximates to half numbers.

	Atlanto Scandian Spring Herring	Bank Herring of the North Sea	South Baltic Autumn Herring
	Norwegian samples (see p. 91)	All material available (see p. 5—22)	All material available (see p. 93)
No.	Freq.	Freq.	Freq.
51	..	1	..
52	..	..	..
53	..	..	..
54	..	1	26
55	..	27	376
56	41	377	355
57	291	363	34
58	291	33	..
59	40	1	..
60	2	..	..
n	665	803	791
m	57.505	56.496	55.502
σ	0.72	0.673	0.634
σ_m	0.028	0.024	0.023
σ_σ	0.019	0.017	0.016

We have seen that in a group of races the average number of vertebrae approximates to whole and half numbers,[1] whilst this does not seem to be the case in another group of races. In all probability there is a connection between this phenomenon and the different habitat of the two groups. The herring races whose average number of vertebrae approximates to whole or half numbers, are mostly found in the large open waters where such factors as the temperature and the salinity have a proportionately uniform and constant character. The herring races of minor importance, whose average number of vertebrae does not seem to approximate to whole or half numbers, are mostly found in fiords and other inshore waters where such factors as the temperature and salinity are varying much from place to place, and also are very changeable on the same locality. Moreover, the named factors, especially the salinity, are often subjected to great changes in the course of a proportionately short time from a geological point of view. Such races

[1] Also in races of other fishes we notice a similar approximation to whole or half numbers in the average no. of vertebrae. The plaice of the North Sea e. g. has very nearly 43.00 vertebrae in mean value (13.00 prec. + 30.00 caud. vert.) Cf. H. M. Kyle 1900, L. Keilhack 1913, G. Duncker 1913.

are probably not so constant and stable as the other races. It is possible, however, that several of the "races" of the last named group from the minor waters consist of mixtures of races of the first group. There is some evidence to hand that the herrings spawning in the inner and less saline parts of the fiords and bays have usually a smaller number of vertebrae than those spawning in the outer parts. In such small waters it is a difficult matter to demonstrate the racial characteristics of the herring races.

In the case of the more variable characters, such as number of keeled scales and number of fin rays, it is more difficult to see whether there is an approximation to a whole number or a half in the means. The environments induce here greater fluctuations from the typical racial mean values than in the case of the vertebrae. In certain cases, however, such an approximation seems to be evident. Thus in the North East Atlantic Herring the average number of rays in the ventral fins approximates to 18.00 $(9.00 + 9.00)$[1], and in the Atlanto-Scandian Herring the average number of keeled scales approximates in all probability to 14.00

I am much obliged to Dr. K. A. Andersson and Mr. David T. Jones for their help in procuring material for my investigations, and I beg my collaborators to accept my best thanks for their valuable assistance in the herring work.

Preparation-work has been carried out by Frøken B. Lockwood Larsen and Hr. cand. S. Weis Fogh.

Countings of vertebrae: Hr. cand. S. Weis Fogh.

Scale readings, countings of rays and keeled scales: Hr. mag. scient. Erik M. Poulsen, Hr. stud. mag. Anton Bruun, Hr. mag. scient. P. Kramp.

Statistical work: Dr. Kirstine Smith, Fru Konsulinde E. Neergaard-Möller, Hr. cand. mag. Aage J. C. Jensen.

The Charts were drawn by Hr. Tegner H. P. Simonsen.

Miss A. G. Davin has been good enough to correct the English translation.

The Tables of the Analyses have been printed at the cost of the Rask-Ørsted Fund.

[1] Comp. p. 51—55.

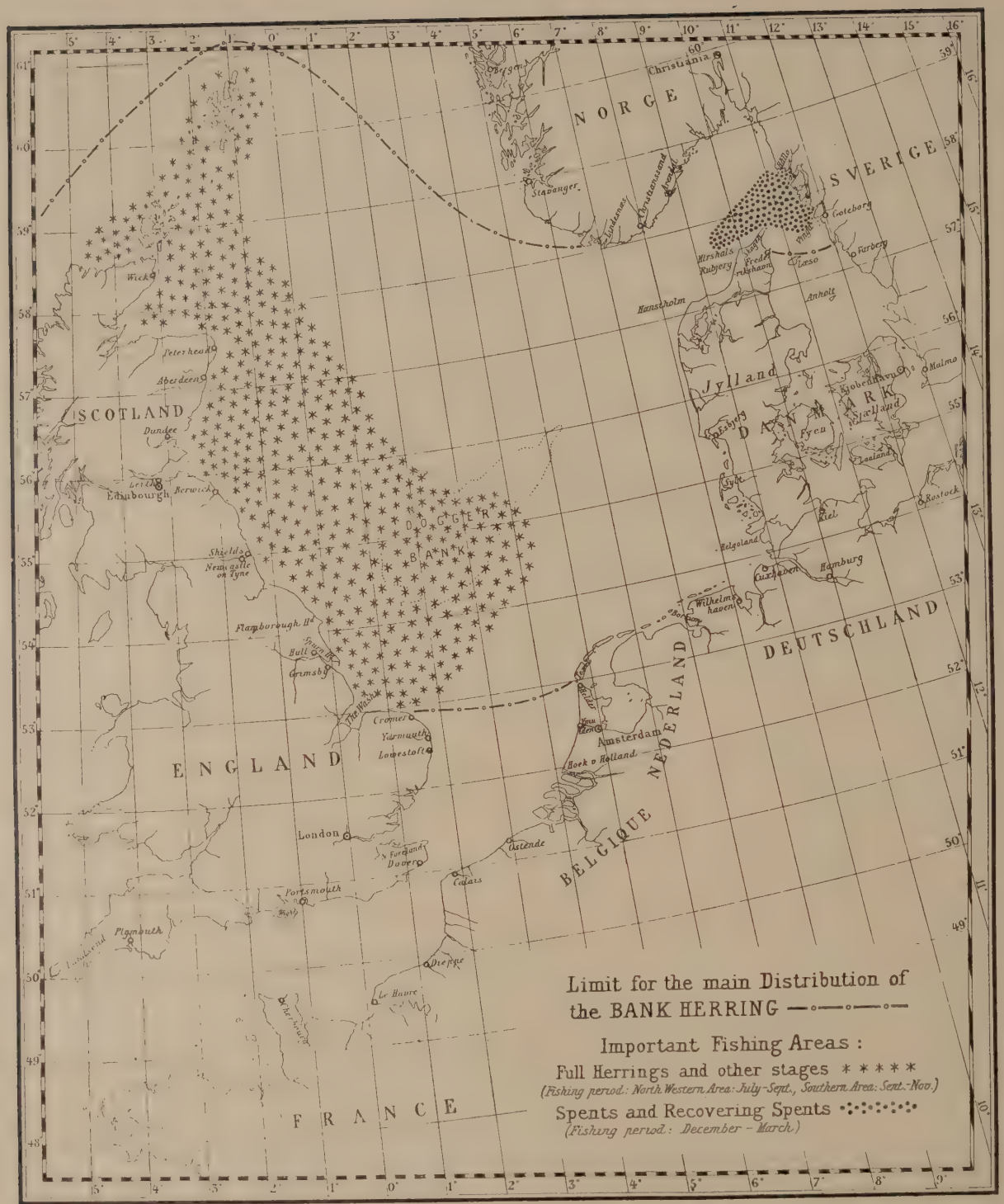

Fig. 15. The main distribution of the Bank Herring of the North Sea, and the situation of important fishing places where this Herring is predominant. (The yearly average catch of the Bank Herring in the North Sea may be estimated at about 350 million kgs. for the period 1904—1913. The yield in the Eastern Skagerak was in the period 1904—23 ca. 40 million kgs., and in the Herring Period from 1887—1896 ca. 150 million kgs pro year).

Tables of the Analyses of Herrings caught in the North Sea and the Skagerak.

(The letter r after the figure denoting number of winter-rings indicates that the last winter-ring is situated quite at the margin, not inside the margin).

A. Herrings from the Shetland Isles.

20 miles S.E. of Balta Sound, Sept. 1. 1921. Maturity III—VII. Caught in Drift Nets.

No.	Length cm	Sex	Maturity	Vertebrae			Keeled scales K_2	Branched Rays in Dorsal fin	Rays in anal fin	Rays in ventral fins		No. of winter-rings in scales approxim.
				Pre-caudal	Caudal	Total				right	left	
1	30.5	♂	IV-VI	24	33	57	16	15	3 + 13[1]	9	9	4
2	29.0	♂	IV-VI	26	30	56	13	17	3 + 15	9	8	c. 8
3	28.5	♀	IV	23	34	57	15	16	3 + 13	9	8	c. 9
4	26.0	♂	IV-VI	23	34	57	17	14	3 + 14	9	9	7
5	28.1	♀	III	24	32	56	13	15	3 + 12	9	9	5
6	28.3	♂	IV-VI	24	33	57	15	15	3 + 14	9	9	4
7	30.0	♀	IV	23	33	56	16	15	3 + 14	9	9	4
8	28.8	♂	IV-VI	24	32	56	15	14	3 + 12	9	9	8
9	29.2	♀	V-VI	24	32	56	14	15	3 + 15	9	8	c. 5
10	28.3	♀	III	24	33	57	13	15	4 + 14	9	9	5
11	29.0	♀	IV	23	34	57	14	16	3 + 15	9	9	6
12	30.5	♀	V-VI	25	32	57	19	15	3 + 13	?	9	8—9
13	28.2	♀	III	24	34	58	15	15	3 + 15	9	9	9
14	29.2	♀	III	24	33	57	14	16	3 + 14	9	9	4(+)
15	28.0	♀	III	25	32	57	15	15	3 + 15	9	9	9
16	28.8	♂	IV-VI	23	33	56	16	15	2 + 14	9	9	8
17	28.8	♂	IV-VI	24	33	57	15	15	3 + 14	9	9	6
18	29.7	♀	V-VI	23	33	56	15	15	3 + 14	9	9	7
19	29.0	♀	IV	23	33	56	14	15	3 + 15	9	9	7
20	28.8	♀	V-VI	23	34	57	14	16	4 + 14	9	9	6—7
21	28.5	♀	V-VI	25	33	58	16	15	3 + 12	9	9	8—12
22	26.6	♀	IV	24	33	57	15	15	3 + 11	9	9	7
23	28.0	♂	IV-VI	23	33	56	15	15	3 + 13	9	9	?
24	28.0	♂	IV-VI	24	32	56	14	16	3 + 16	9	9	4
25	29.3	♀	IV	23	33	56	15	15	3 + 14	8	9	c. 4
26	30.2	♀	V-VI	23	34	57	15	15	3 + 14	9	9	7
27	31.0	♂	IV-VI	25	32	57	14	15	3 + 15	9	9	c. 7—8
28	27.2	♀	IV	24	33	57	14	15	3 + 14	9	9	7
29	28.5	♀	V-VI	24	32	56	15	15	3 + 15	9	9	c. 5
30	29.5	♀	III	24	33	57	15	16	3 + 14	9	9	8
31	28.4	♂	IV-VI	23	34	57	15	15	3 + 15	9	9	5
32	27.5	♂	IV-VI	24	33	57	15	16	4 + 15	9	9	7
33	28.0	♀	V-VI	24	33	57	14	16	3 + 15	9	9	4
34	27.0	♀	V-VI	25	32	57	15	15	3 + 14	9	9	7
35	28.7	♀	V-VI	25	31	56	15	16	3 + 13	9	9	8
36	28.3	♀	V-VI	23	33	56	15	15	3 + 13	9	8	8
37	30.7	♀	IV	26	30	56	15	15	3 + 13	9	9	9
38	29.5	♀	IV	25	32	57	14	15	3 + 14	9	9	10
39	29.6	♀	V-VI	24	34	58	15	15	3 + 14	9	9	7
40	28.0	♀	III	24	32	56	15	16	3 + 14	9	9	6
41	28.2	♀	IV	25	32	57	17	14	3 + 15	9	9	6
42	30.0	♂	IV-VI	24	33	57	14	16	3 + 13	9	9	9
43	31.2	♀	V-VI	24	33	57	15	15	4 + 14	9	9	9
44	26.7	♀	III	24	32	56	16	16	4 + 13	9	8	7
45	29.7	♂	IV-VI	23	33	56	14	15	3 + 13	9	9	7
46	25.8	♂	IV-VI	23	34	57	14	15	3 + 13	9	9	(6-)7
47	26.3	♂	IV-VI	24	33	57	15	15	2 + 15	9	9	4
48	26.7	♂	IV-VI	24	32	56	15	15	3 + 14	9	9	7
49	27.8	♂	IV-VI	24	32	56	16	15	3 + 14	9	9	8
50	27.0	♀	IV	23	34	57	16	15	3 + 15	9	9	c. 5
51	28.0	♂	IV-VI	24	32	56	14	14	3 + 14	9	9	6
52	31.4	♀	V-VI	24	32	56	15	15	4 + 14	9	9	?
53	28.0	♀	III	24	32	56	15	16	4 + 15	9	9	7
54	28.5	♂♀	IV-VI	22	34	56	15	15	3 + 13	8	8	6—7
55	28.2	♀	III	24	32	56	15	15	3 + 14	9	9	6
56	29.2	♀	IV	25	32	57	15	15	4 + 13	9	9	?
57	28.2	♂	IV-VI	24	34	58	16	?	3 + 14	9	9	5
58	26.3	♀	IV	24	33	57	15	16	3 + 14	9	9	5
59	28.5	♂	IV-VI	24	33	57	15	14	4 + 15	9	9	7-(8)
60	28.0	♀	V-VI	27	30	57	17	15	2 + 16	8	8	?
61	29.0	♀	V-VI	24	33	57	15	14	3 + 15	9	9	7
62	28.5	♂	IV-VI	25	32	57	13	14	3 + 14	9	9	c. 6
63	30.0	♀	V-VI	24	33	57	15	15	3 + 15	?	9	7(-8)
64	29.5	♀	V-VI	23	33	56	13	15	2 + 16	9	?	6—7
65	27.5	♀	IV	24	32	56	15	15	3 + 14	9	9	5
66	27.5	♂	IV-VI	23	33	56	16	15	4 + 13	9	8	7
67	27.5	♀	III	24	31	55	15	15	3 + 13	9	9	6
68	28.7	♀	IV	24	33	57	15	15	3 + 13	9	8	?
69	27.3	♀	V-VI	26	31	57	13	15	3 + 13	8	8	5
70	29.5	♀	V-VI	24	32	56	15	16	3 + 15	9	9	6
71	31.0	♀	V-VI	23	34	57	13	15	3 + 14	9	9	8
72	29.4	♀	V-VI	24	32	56	17	15	3 + 14	9	9	8
73	27.5	♀	IV	24	34	58	14	15	3 + 15	9	9	c. 6
74	27.2	♀	III	24	33	57	14	14	3 + 15	9	9	7
75	29.2	♀	V-VI	24	32	56	14	15	3 + 13	9	9	7
76	29.2	♂	IV-VI	25	32	57	14	?	3 + 13	8	8	8
77	29.2	♂	IV-VI	23	33	56	16	15	3 + 13	9	9	6
78	28.5	♂	IV-VI	24	33	57	16	16	3 + 15	9	9	8
79	27.3	♀	IV	24	33	57	16	15	3 + 12	9	9	7
80	28.5	♀	IV	24	32	56	14	16	3 + 15	9	9	5
81	29.6	♂	IV-VI	22	33	55	14	15	3 + 14	10	9	10
82	28.5	♀	V-VI	23	33	56	15	15	3 + 14	9	9	10
83	28.0	♀	IV	24	32	56	14	15	3 + 14	9	9	c. 5
84	27.0	♀	V-VI	26	30	56	15	15	3 + 14	9	9	6
85	28.5	♂	IV-VI	23	33	56	15	14	3 + 13	9	9	5—6
86	28.3	♀	IV	23	33	56	16	14	3 + 15	8	8	5
87	29.8	♀	V-VI	24	33	57	16	16	3 + 14	8	9	7
88	27.5	♂	IV-VI	24	32	56	15	15	3 + 14	9	9	5
89	27.5	♂	IV-VI	24	32	56	14	15	3 + 13	9	9	9
90	28.0	♀	IV	24	32	56	15	15	3 + 15	9	8	6—7
91	27.0	♂	IV-VI	25	32	57	16	15	3 + 14	9	9	5
92	30.1	♀	V-VI	24	32	56	13	16	3 + 14	8	8	5
93	28.8	♂	IV-VI	23	33	56	14	16	3 + 15	9	9	8
94	27.2	♂	IV-VI	25	32	57	15	15	3 + 13	8	9	6
95	27.8	♀	III	25	32	57	15	15	3 + 15	9	9	5
96	27.2	♀	III	23	33	56	14	15	3 + 15	9	9	7
97	29.5	♀	IV	24	32	56	15	15	3 + 12	9	9	8
98	28.0	♀	IV	23	34	57	16	16	3 + 14	9	9	6—7
99	28.0	♂	IV-VI	24	33	57	15	15	4 + 14	9	9	8
100	28.7	♀	III	23	33	56	15	14	3 + 14	9	9	8
101	31.5	♂	IV-VI	23	34	57	16	16	3 + 13	8	8	8
102	27.8	♀	III	23	33	56	15	15	3 + 13	9	9	5
103	28.5	♂♀	IV-VI	23	33	56	13	15	3 + 14	9	9	(5-)6
104	27.0	♀	V-VI	24	32	56	15	15	3 + 14	9	9	4

[1] Unbranched plus branched rays.

No.	Length cm	Sex	Maturity	Vertebrae: Pre-caudal	Caudal	Total	Keeled scales Kg	Branched Rays in Dorsal fin	Rays in anal fin	Rays in ventral fins: right	left	No. of winter-rings in scales approxim.
105	26.5	♀	III	25	32	57	15	14	3 + 11	9	9	5
106	27.8	♀	V-VI	24	32	56	11	17	3 + 15	8	8	7
107	29.2	♀	V-VI	23	33	56	15	16	3 + 14	8	9	9
108	30.1	♀	IV-VI	22	35	57	15	14	3 + 14	9	9	6
109	29.4	♀	IV-VI	24	34	58	15	16	3 + 15	9	9	6
110	29.2	♀	V-VI	24	32	56	15	15	3 + 13	8	9	6
111	30.2	♀	IV-VI	24	34	58	15	14	? + 13	9	9	c. 6
112	27.5	♀	IV-VI	23	33	56	16	15	3 + 15	9	9	3—4
113	28.5	♀	IV-VI	24	32	56	15	16	3 + 15	9	9	8
114	28.4	♀	V-VI	23	33	56	15	16	3 + 15	9	9	7—8
115	27.1	♀	IV-VI	23	34	57	13	16	3 + 14	8	9	8
116	30.5	♀	VII	23	32	55	14	15	3 + 13	9	8	8
117	29.0	♀	V-VI	24	32	56	14	15	3 + 14	9	9	6
118	29.0	♀	IV-VI	24	31	56	15	16	3 + 14	9	9	6
119	28.6	♀	IV	24	32	56	15	16	3 + 14	9	9	6
120	29.2	♀	V-VI	24	32	56	15	16	4 + 15	9	9	8
121	27.0	♀	IV-VI	24	32	56	17	16	?	9	9	6—7
122	28.0	♀	V-VI	22	34	56	16	16	4 + 13	9	9	7
123	29.5	♀	IV-VI	24	34	58	14	16	3 + 15	9	9	5
124	29.2	♀	IV	24	32	56	15	15	3 + 14	9	9	7
125	28.8	♀	V-VI	24	33	57	14	15	4 + 15	9	9	6
126	27.2	♀	IV-VI	21	34	58	15	15	1 + 13	9	9	4
127	26.0	♀	IV-VI	23	34	57	16	15	2 + 15	9	10	?
128	30.5	♀	V-VI	26	31	57	15	15	3 + 13	8	8	8
129	29.0	♀	IV	23	34	57	14	15	3 + 12	8	8	8
130	28.5	♀	IV-VI	24	33	57	15	15	4 + 14	9	9	7
131	28.7	♀	V-VI	23	34	57	15	14	3 + 15	9	9	?
132	30.0	♀	V-VI	23	33	56	16	15	2 + 13	8	8	8
133	29.5	♀	IV	24	33	57	14	?	4 + 15	9	9	8
134	28.4	♀	IV	23	33	56	15	15	3 + 11	9	9	8
135	30.6	♀	IV-VI	23	33	56	15	15	4 + 14	9	9	9—10
136	27.5	♀	III	24	33	57	15	15	3 + 15	9	9	5
137	29.2	♀	V-VI	23	34	57	15	16	3 + 14	8	8	6
138	28.0	♀	IV	25	31	56	15	15	3 + 13	9	9	9
139	27.3	♀	IV	24	33	57	14	15	3 + 14	9	9	4
140	29.0	♀	V-VI	25	31	56	14	14	3 + 15	9	9	7
141	29.5	♀	V-VI	24	32	56	17	15	3 + 15	9	9	7
142	29.0	♀	V-VI	23	33	56	15	15	3 + 13	9	9	9
143	27.5	♀	IV-VI	24	33	57	15	14	3 + 14	9	9	7(-8)
144	27.8	♀	IV-VI	24	33	57	15	14	3 + 14	9	9	7
145	28.0	♀	V-VI	24	33	57	15	15	2 + 15	9	9	8
146	26.2	♀	V-VI	24	33	57	15	15	3 + 14	9	9	4
147	27.0	♀	IV-VI	24	32	56	15	15	4 + 13	9	9	4
148	29.0	♀	V-VI	25	33	58	16	15	3 + 13	9	9	5
149	29.5	♀	IV-VI	24	32	56	15	15	3 + 15	9	9	7
150	26.8	♀	IV	25	32	57	14	15	3 + 15	9	9	6
151	29.2	♀	IV	23	34	57	15	15	2 + 14	8	8	9—10
152	28.2	♀	V-VI	23	32	55	11	14	3 + 11	9	9	5
153	27.2	♀	IV	24	33	57	15	15	3 + 13	9	9	6
154	27.8	♀	IV-VI	24	33	57	14	15	3 + 13	9	9	7
155	30.5	♀	V-VI	24	32	56	16	16	3 + 13	9	9	8
156	28.0	♂	IV-VI	25	32	57	14	15	3 + 16	9	10	6
157	29.5	♂	IV-VI	24	32	56	16	15	3 + 14	9	9	5
158	27.1	♂	IV	24	32	56	15	16	2 + 15	9	9	6
159	29.5	♂	IV-VI	24	33	57	15	16	3 + 14	9	9	6(-7)
160	26.6	♂	IV-VI	23	34	57	15	15	3 + 11	8	9	5
161	28.2	♂	IV	24	32	56	15	15	3 + 14	9	9	7
162	30.2	♂	V-VI	24	32	56	15	14	3 + 14	9	9	7—8
163	28.4	♂	IV	23	34	57	16	15	3 + 14	9	8	?
164	27.5	♂	V-VI	24	32	56	15	16	?	9	9	4
165	25.9	♂	III	24	33	57	11	15	3 + 11	9	9	5
166	29.3	♂	V-VI	24	32	56	11	16	3 + 15	9	8	6
167	28.5	♂	IV	24	33	57	15	15	4 + 13	9	9	c. 5
168	26.6	♂	IV-VI	23	33	56	14	15	3 + 13	9	9	7
169	29.0	♂	V-VI	24	33	57	14	16	3 + 15	9	9	8
170	28.0	♂	V-VI	24	32	56	15	16	3 + 15	9	9	5
171	28.8	♂	V-VI	23	33	56	15	16	3 + 15	9	9	5—6
172	29.2	♂	IV	24	32	56	14	14	3 + 13	9	9	7
173	28.3	♂	V-VI	24	34	58	15	15	3 + 14	9	9	5
174	28.0	♂	IV-VI	24	33	57	15	15	3 + 13	9	9	9
175	29.0	♂	IV-VI	25	32	57	15	16	1 + 13	9	9	c. 8
176	30.4	♂	IV-VI	23	33	56	14	15	3 + 13	9	9	8—9
177	28.7	♂	V-VI	23	34	57	15	15	3 + 15	9	8	7
178	27.0	♂	IV-VI	23	33	56	14	16	3 + 14	9	9	5
179	28.5	♂	IV-VI	26	32	58	15	17	3 + 15	9	9	4—5
180	27.0	♀	V-VI	24	33	57	15	15	2 + 15	9	9	4
181	26.5	♀	IV	24	32	56	15	15	3 + 13	9	9	5
182	28.2	♀	IV	23	34	57	15	14	4 + 13	9	9	6
183	29.7	♀	IV-VI	24	32	56	13	15	2 + 15	9	9	5
184	28.8	♀	IV-VI	20	31	51	14	14	3 + 13	9	9	8
185	27.8	♀	III	23	33	56	15	16	3 + 14	9	9	6
186	27.0	♀	IV	26	30	56	14	16	2 + 15	9	9	5
187	28.4	♂	IV-VI	23	33	56	15	16	3 + 15	9	9	c. 7
188	27.0	♂	IV-VI	24	33	57	15	15	4 + 15	9	9	5—6
189	28.0	♂	IV-VI	24	33	57	15	15	3 + 14	9	9	5
190	28.8	♂	IV-VI	23	33	56	14	16	3 + 16	9	9	9
191	27.7	♂	IV-VI	25	32	57	15	15	3 + 14	8	8	7
192	30.6	♂	V-VI	23	33	56	15	15	3 + 14	9	9	c. 8
193	27.8	♂	IV	24	33	57	14	16	3 + 14	9	9	7
194	30.6	♂	V-VI	23	34	57	14	14	3 + 15	9	9	11
195	30.2	♂	V-VI	25	32	57	14	15	3 + 15	9	9	6
196	28.0	♂	IV	25	32	57	15	15	3 + 14	9	9	8
197	31.0	♂	V-VI	24	32	56	14	15	3 + 15	9	9	4—5
198	29.5	♂	IV-VI	24	33	57	15	15	3 + 16	9	9	6
199	27.0	♂	IV-VI	25	31	56	15	..	3 + 14	9	9	7
200	27.6	♂	IV-VI	24	33	57	16	15	3 + 15	9	9	4
201	27.6	♂	V-VI	24	32	56	17	16	3 + 13	9	9	5
202	28.0	♂	IV-VI	23	33	56	16	15	3 + 14	8	8	8
203	31.0	♂	IV-VI	23	32	55	16	16	3 + 14	8	8	6
204	27.0	♂	IV-VI	24	32	56	14	15	4 + 13	9	9	6
205	28.7	♂	V-VI	24	32	56	14	15	3 + 15	9	9	4
206	30.8	♂	V-VI	24	33	57	14	15	3 + 14	8	7	9
207	29.2	♂	V-VI	23	34	57	15	15	2 + 15	9	9	5
208	29.8	♂	V-VI	23	34	57	15	14	2 + 15	9	9	9
209	28.0	♂	V-VI	22	34	56	17	16	3 + 14	9	9	5
210	28.2	♂	V-VI	22	34	56	15	14	?	8	9	8
211	29.4	♂	V-VI	23	33	56	15	14	3 + 14	9	9	7
212	27.0	♂	IV-VI	26	31	57	15	16	3 + 14	9	9	5
213	27.3	♂	IV-VI	24	32	56	16	16	3 + 14	9	9	?
214	28.2	♂	III	24	34	58	15	14	4 + 14	9	9	6
215	29.0	♂	V-VI	22	35	57	15	15	3 + 15	9	9	5
216	29.8	♂	V-VI	26	31	57	14	14	3 + 15	9	10	5
217	29.0	♂	IV-VI	25	31	56	15	14	3 + 13	9	9	10
218	27.5	♂	IV	24	32	56	14	15	3 + 14	9	9	?
219	28.0	♂	V-VI	23	33	56	15	16	3 + 14	9	9	5
220	27.2	♂	IV-VI	24	34	58	17	16	3 + 15	9	9	7
221	26.6	♂	V-VI	24	32	56	15	16	3 + 14	9	10	5
222	28.5	♂	IV	24	33	57	14	15	3 + 13	9	8	7
223	28.5	♂	IV	24	32	56	13	15	3 + 15	9	9	5—6
224	28.4	♂	IV-VI	24	33	57	15	16	3 + 15	9	9	5
225	27.0	♂	IV-VI	23	33	56	16	15	4 + 13	9	8	8
226	28.7	♂	V-VI	24	33	57	14	14	3 + 13	9	9	7
227	27.2	♂	IV-VI	24	33	57	15	15	3 + 14	9	9	5
228	26.5	♂	IV-VI	22	33	55	17	14	3 + 11	9	9	5
229	29.0	♂	IV-VI	24	33	57	15	16	3 + 15	9	9	?
230	28.4	♂	IV	24	33	57	15	15	2 + 13	9	9	9
231	29.0	♂	V-VI	23	34	57	16	15	3 + 14	8	8	8
232	28.5	♂	V-VI	25	32	57	15	16	3 + 15	9	9	9
233	31.0	♂	V-VI	23	33	56	14	15	3 + 15	9	9	7
234	30.8	♂	V-VI	24	33	57	14	16	1 + 14	8	8	6—9
235	28.7	♂	IV	23	34	57	14	15	4 + 13	8	8	8
236	27.5	♂	IV	24	32	56	16	15	3 + 14	9	9	?
237	28.7	♂	IV	24	32	56	15	15	3 + 14	9	9	7
238	28.5	♂	IV	24	32	56	14	15	3 + 13	9	9	4(-5)
239	28.6	♂	III	24	32	56	15	15	3 + 14	9	9	5—6
240	28.2	♂	IV	24	33	57	14	15	3 + 13	9	9	8
241	29.3	♂	V-VI	24	33	57	15	15	3 + 14	9	8	7—8
242	29.5	♂	V-VI	26	33	59	16	16	?	9	8	5
243	28.5	♂	IV-VI	23	34	57	15	14	4 + 14	9	9	5
244	27.5	♂	IV-VI	22	34	56	14	15	3 + 14	9	9	6
245	30.6	♂	V-VI	23	34	57	16	15	3 + 13	8	8	9
246	28.2	♂	IV	23	33	56	16	15	3 + 14	9	9	5
247	30.0	♂	V-VI	26	31	57	15	15	2 + 15	9	9	9
248	30.3	♂	IV-VI	24	34	58	14	14	3 + 15	9	9	c. 7
249	29.5	♂	V-VI	24	32	56	14	15	3 + 15	9	9	c. 7
250	28.3	♂	IV-VI	25	32	57	14	15	3 + 15	9	9	5
251	26.8	♂	V-VI	24	32	56	15	15	3 + 14	9	9	3
252	29.4	♂	IV	24	32	56	15	15	3 + 15	9	9	c. 7
253	28.8	♂	IV	24	32	56	15	15	3 + 14	8	8	6
254	27.3	♂	IV-VI	25	32	57	16	16	4 + 14	9	9	6

No.	Length cm	Sex	Maturity	Vertebrae			Keeled scales K_2	Branched Rays in Dorsal fin	Rays in anal fin	Rays in ventral fins		No. of winter-rings in scales approxim.
				Pre-caudal	Caudal	Total				right	left	
255	26.8	♀	IV	23	31	54	16	16	3 + 14	8	8	c. 8
256	29.0	♀	IV	25	32	57	14	14	3 + 13	9	9	8
257	28.2	♀	III	23	33	56	15	15	3 + 13	9	9	5—6
258	29.0	♀	V-VI	23	33	56	15	15	3 + 12	9	8	9—10
259	27.5	♀	V-VI	24	33	57	15	15	3 + 15	9	9	4
260	27.7	♂	IV-VI	24	32	56	15	15	3 + 15	9	9	5
261	29.2	♂	IV-VI	24	33	57	16	16	3 + 14	9	9	7
262	27.0	♀	V-VI	25	31	56	15	15	3 + 15	9	9	5
263	27.6	♀	V-VI	24	32	56	14	15	3 + 13	9	9	5
264	28.0	♂	IV-VI	24	32	56	16	15	3 + 14	9	9	6
265	26.5	♂	IV-VI	24	32	56	14	16	4 + 13	9	9	5
266	28.5	♀	IV-VI	24	33	57	14	16	3 + 15	9	9	7
267	28.3	♀	V-VI	24	32	56	15	15	3 + 13	9	9	(6-)7
268	26.7	♀	V-VI	24	33	57	14	16	3 + 16	9	9	5
269	29.8	♀	III	24	34	58	14	14	3 + 15	9	9	5
270	27.7	♂	IV-VI	24	33	57	15	14	3 + 14	9	9	5(-6)
271	26.0	♂	IV-VI	24	32	56	16	16	3 + 13	9	9	6
272	27.5	♂	IV-VI	23	33	56	13	16	3 + 15	9	9	6
273	28.3	♀	V-VI	22	34	56	15	15	4 + 13	9	9	?
274	29.2	♀	IV-VI	23	34	57	15	15	2 + 14	9	9	6
275	28.2	♀	IV	24	34	58	16	15	3 + 15	9	9	7
276	28.5	♂	IV	24	32	56	14	15	3 + 14	8	8	7
277	28.5	♂	IV-VI	25	32	57	15	14	4 + 13	9	9	7
278	27.5	♂	IV-VI	24	33	57	16	15	3 + 14	9	9	c. 6
279	28.3	♀	IV	23	33	56	14	16	3 + 16	8	9	5(-6)
280	29.7	♀	V-VI	22	35	57	15	15	2 + 13	9	9	9
281	28.8	♂	IV-VI	23	34	57	14	15	3 + 15	9	9	7
282	28.7	♀	IV	24	33	57	13	16	? + 14	9	9	8
283	26.7	♂	IV-VI	24	32	56	15	15	2 + 14	9	9	6
284	27.5	♀	V-VI	26	31	57	15	14	4 + 13	9	8	5
285	29.5	♀	III	23	33	56	15	15	3 + 13	9	9	7
286	29.0	♂	IV-VI	24	32	56	14	15	4 + 13	9	9	8
287	28.8	♂	IV-VI	24	33	57	15	15	3 + 15	10	9	4
288	30.2	♀	V-VI	23	34	57	15	15	3 + 15	9	9	8
289	28.0	♀	III	24	32	56	14	15	3 + 14	9	9	?
290	28.5	♂	IV-VI	23	33	56	14	14	4 + 14	8	9	6
291	28.0	♀	III	24	32	56	16	16	3 + 13	9	9	?
292	28.5	♂	IV-VI	24	32	56	14	15	3 + 14	9	9	7
293	26.7	♂	IV-VI	23	33	56	14	14	4 + 13	9	9	?
294	27.8	♂	IV-VI	23	33	56	15	14	3 + 14	9	8	6
295	27.4	♂	IV-VI	23	34	57	14	16	3 + 14	9	8	?
296	28.2	♀	IV	24	32	56	14	15	3 + 16	9	9	5
297	29.0	♂	IV-VI	23	33	56	16	14	3 + 13	9	9	6
298	28.2	♂	IV-VI	25	32	57	15	14	3 + 12	9	9	9
299	27.7	♂	IV-VI	25	32	57	14	15	3 + 13	8	8	5
300	27.5	♂	IV-VI	24	32	56	14	15	3 + 12	9	9	7
301	28.2	♂	IV-VI	25	31	56	15	16	3 + 14	9	9	7
302	29.7	♂	IV-VI	23	34	57	14	16	3 + 15	9	9	7
303	28.7	♀	V-VI	23	34	57	13	15	3 + 16	8	8	7
304	28.0	♀	V-VI	24	33	57	15	15	3 + 13	9	9	?
305	27.2	♂	IV-VI	23	33	56	15	15	2 + 14	9	9	5
306	31.8	♀	V-VI	25	31	56	15	15	3 + 14	10	10	8
307	27.2	♂	IV-VI	25	32	57	16	15	4 + 13	9	9	?
308	30.0	♂	IV-VI	25	32	57	14	15	3 + 15	9	9	7
309	29.3	♂	IV-VI	24	32	56	16	15	3 + 13	9	9	6
310	30.2	♀	V-VI	25	32	57	15	15	2 + 15	8	8	?
311	28.5	♂♀	V-VI	25	32	57	14	15	3 + 15	9	9	4
312	29.2	♂♀	V-VI	25	31	56	15	15	3 + 12	9	9	5
313	28.0	♂♀	IV-VI	24	33	57	16	15	3 + 15	9	9	?
314	28.0	♂♀	IV-VI	24	32	56	15	14	3 + 14	9	9	6
315	28.0	♂	IV-VI	24	33	57	15	16	3 + 15	9	9	?
316	29.6	♂♀	IV-VI	24	33	57	16	15	3 + 14	8	8	7
317	26.1	♂♀	IV-VI	23	32	55	16	16	3 + 14	9	9	7
318	26.5	♂♀	IV-VI	24	32	56	14	15	3 + 14	9	9	5
319	28.5	♂♀	IV-VI	23	33	56	14	14	3 + 14	8	8	5
320	30.0	♂	V-VI	23	34	57	15	15	3 + 14	9	9	c. 5
321	27.2	♂♀	IV-VI	23	34	57	16	15	3 + 14	9	8	6
322	28.2	♂	IV-VI	24	32	56	14	15	3 + 13	9	9	8
323	28.2	♂	IV-VI	25	32	57	14	16	3 + 14	8	8	8—9
324	28.5	♂	IV-VI	24	32	56	14	15	3 + 12	9	8	4
325	28.7	♂	IV-VI	24	32	56	14	15	3 + 14	9	9	7
326	27.0	♂	IV-VI	24	32	56	14	15	3 + 12	9	9	7
327	30.0	♀	VII	23	33	56	15	16	3 + 17	9	9	6—7
328	29.8	♀	V-VI	23	33	56	15	15	3 + 14	9	9	5
329	28.2	♀	V-VI	22	34	56	14	14	3 + 14	9	9	8
330	30.0	♀	V-VI	24	32	56	16	15	3 + 15	8	8	c. 8
331	27.1	♀	V-VI	24	32	56	16	14	3 + 13	8	8	6
332	28.8	♀	V-VI	24	34	58	15	14	3 + 16	9	9	7
333	28.2	♀	V-VI	23	33	56	15	16	?	9	9	?6
334	27.4	♀	V-VI	23	33	56	15	14	?	9	9	9
335	29.8	♀	V-VI	22	34	56	17	15	3 + 14	9	9	7
336	30.6	♀	V-VI	25	32	57	14	15	3 + 16	9	9	8
337	28.0	♀	V-VI	25	30	55	14	14	4 + 15	8	8	8
338	28.8	♀	V-VI	23	33	56	15	15	4 + 14	9	9	5
339	28.0	♀	V-VI	23	34	57	15	15	2 + 14	9	9	5
340	29.8	♀	V-VI	24	33	57	15	16	3 + 14	9	9	8
341	30.8	♀	V-VI	25	31	56	14	15	4 + 14	9	9	c. 7
342	29.3	♀	V-VI	22	34	56	15	14	3 + 14	9	9	5
343	29.5	♀	V-VI	24	33	57	15	16	3 + 14	9	8	c. 8
344	29.1	♀	V-VI	24	33	57	15	15	3 + 14	9	8	7
345	26.2	♀	V-VI	25	32	57	15	14	3 + 14	9	9	?
346	30.7	♀	V-VI	24	32	56	15	16	3 + 14	8	8	8
347	27.5	♀	IV	24	33	57	14	14	3 + 13	9	9	7
348	28.0	♀	V-VI	24	33	57	16	14	3 + 14	9	9	6
349	29.5	♀	V-VI	23	33	56	15	15	3 + 13	9	9	7
350	27.3	♀	IV	23	34	57	15	15	4 + 13	9	9	6
351	27.0	♀	V-VI	26	31	57	14	16	3 + 13	9	9	6
352	27.2	♀	V-VI	25	32	57	15	14	3 + 13	9	9	6
353	28.2	♀	IV	23	34	57	15	16	3 + 16	9	9	6
354	28.7	♀	V-VI	26	29	55	13	14	3 + 13	8	9	9
355	29.5	♀	IV	25	32	57	15	15	4 + 13	9	9	8
356	29.2	♀	V-VI	23	34	57	14	15	3 + 14	9	9	7
357	28.5	♀	V-VI	23	34	57	16	15	3 + 15	9	9	?8
358	28.3	♀	IV	23	33	56	15	15	3 + 14	9	9	7
359	29.5	♀	V-VI	24	32	56	15	15	2 + 15	9	9	5—6
360	28.5	♀	IV	24	33	57	14	14	3 + 15	9	9	6
361	30.0	♀	V-VI	23	34	57	15	16	3 + 16	9	8	10
362	28.2	♀	IV	24	33	57	15	15	3 + 15	9	9	4
363	28.0	♀	V-VI	24	33	57	17	15	?	9	9	5—6

B. Young Herrings from South West of Graadeep.

Nov. 30. 1922. Maturity I. Caught by Herring Trawl from the "Dana".

No.	Length cm	Vertebrae			Keeled scales K_2	Rays in ventral fins		No. of winter-rings in scales	No.	Length cm	Vertebrae			Keeled scales K_2	Rays in ventral fins		No. of winter-rings in scales
		Pre-caudal	Caudal	Total		right	left				Pre-caudal	Caudal	Total		right	left	
1	10.1	25	32	57	16	9	9	0	7	9.8	23	33	56	14	9	9	0
2	9.2	23	33	56	14	8	9	0	8	9.7	24	32	56	15	9	9	0
3	10.8	24	32	56	15	9	9	0	9	10.9	26	31	57	14	9	9	0
4	10.0	24	32	56	16	9	9	0	10	9.6	23	32	55	15	9	9	0
5	11.2	24	33	57	15	9	9	0	11	9.2	25	31	56	16	9	9	0
6	9.4	23	33	56	14	9	9	0	12	9.1	24	33	57	14	9	9	0

No.	Length cm	Vertebrae			Keeled scales K_2	Rays in ventral fins		No. of winter-rings in scales
		Pre-caudal	Caudal	Total		right	left	
13	9.5	24	32	56	15	9	10	0
14	10.2	24	32	56	17	8	8	0
15	9.7	24	32	56	14	9	8	0
16	10.2	25	32	57	16	9	9	0
17	9.8	23	33	56	16	9	9	0
18	10.1	25	31	56	15	9	9	0
19	9.6	24	33	57	14	9	9	0
20	9.1	24	33	57	16	8	8	0
21	9.3	24	32	56	14	9	9	0
22	9.5	24	32	56	15	9	9	0
23	10.2	24	32	56	15	9	9	0
24	9.7	25	31	56	15	8	9	0
25	9.6	22	35	57	16	9	9	0
26	9.5	23	34	57	17	9	9	0
27	10.6	23	33	56	16	9	9	0
28	9.8	23	33	56	15	9	9	0
29	9.8	24	33	57	16	8	9	0
30	10.1	23	35	58	15	9	9	0
31	9.5	23	33	56	14	9	8	0
32	9.6	25	32	57	16	8	8	0
33	10.0	23	33	56	16	9	9	0
34	9.9	25	31	56	15	9	9	0
35	9.2	23	34	57	14	9	8	0
36	10.2	25	33	58	15	9	9	0
37	10.5	24	33	57	16	8	9	0
38	9.5	24	32	56	16	9	8	0
39	10.2	24	32	56	14	9	9	0
40	10.0	24	32	56	14	9	9	0
41	9.9	24	32	56	16	9	9	0
42	10.0	25	30	55	16	9	8	0
43	9.2	26	32	58	15	9	9	0
44	9.5	24	32	56	16	9	9	0
45	9.5	24	32	56	16	9	9	0
46	10.9	25	32	57	16	9	9	0
47	10.4	24	32	56	15	9	9	0
48	9.6	24	33	57	16	9	9	0
49	9.8	23	33	56	15	8	8	0
50	11.0	24	33	57	15	9	9	0

C. Herrings from N. W. of Hirshals. (c. 57° 45′ N. 9° 15′ E.)

March. 6. 1923. Caught in Purse Seine.

a. Young mixed Herrings. Maturity I—II.

No.	Length cm	Sex	Maturity	Vertebrae			Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventr. fins		No. of winter-rings in scales approxim.
				Pre-caudal	Caudal	Total				right	left	
1	23	♂+♀	I	24	33	57	14	15	3+15	9	9	4
2	23	♂+♀	I	24	33	57	14	16	3+14	9	9	3r
3	23	♂+♀	I	22	34	56	14	15	3+17	9	9	3
4	23	♂+♀	I	25	33	58	14	17	3+15	9	9	4r
5	23	♂+♀	I	25	33	58	14	16	3+16	9	9	3r
6	22	♂+♀	I	24	33	57	14	16	3+15	8	9	3
7	22	♂+♀	I	24	33	57	14	15	3+15	9	9	3
8	22	♂+♀	I	23	33	56	14	15	3+15	10	9	3
9	22	♂+♀	I	25	31	56	13	15	4+15	9	9	3
10	22	♂+♀	I	23	34	57	14	14	?	9	9	3?
11	22	♂+♀	I	25	31	56	15	16	3+15	9	9	3r
12	22	♂+♀	I	25	32	57	13	15	3+15	9	9	5
13	22	♂+♀	I	25	32	57	14	15	4+15	9	9	4
14	22	♂+♀	I	24	33	57	13	15	3+15	9	8	3
15	22	♂+♀	I	23	34	57	17	15	3+16	9	9	3
16	22	♂+♀	I	24	33	57	14	15	3+14	9	9	?
17	22	♂+♀	I	24	33	57	14	16	3+17	9	9	3
18	22	♂+♀	I	23	33	56	?	16	3+14	9	9	3
19	22	♂+♀	I	24	32	56	15	16	3+14	8	8	3
20	22	♂+♀	I	24	32	56	15	15	3+15	7	7	?
21	22	♂+♀	I	22	34	56	15	16	3+15	8	8	4
22	22	♂+♀	I	23	34	57	13	15	3+16	9	9	3r
23	22	♂+♀	I	24	33	57	15	15	3+16	8	8	3r
24	22	♂+♀	I	25	31	56	14	16	3+16	8	8	4
25	22	♂+♀	I	24	33	57	15	15	3+15	9	9	3
26	22	♂+♀	I	23	34	57	15	15	4+14	9	9	3r
27	22	♂+♀	I	23	34	57	13	15	4+13	9	9	3
28	22	♂+♀	I	24	32	56	14	15	3+15	9	9	5r
29	22	♂+♀	I	24	33	57	13	15	3+15	8	9	3
30	21	♂+♀	I	24	33	57	15	15	3+14	9	9	4r
31	21	♂+♀	I	24	32	56	15	16	3+15	9	10	4r
32	21	♂+♀	I	24	33	57	14	16	3+15	9	9	3
33	21	♂+♀	I	25	32	57	15	15	3+13	9	9	3r
34	21	♂+♀	I	25	32	57	15	17	3+15	9	9	3
35	21	♂+♀	I	24	32	56	16	16	3+14	8	8	3
36	21	♂+♀	I	25	31	56	16	16	3+15	9	9	4
37	21	♂+♀	I	24	33	57	14	14	3+15	9	9	3r
38	21	♂+♀	I	23	34	57	14	15	3+14	9	9	4r
39	21	♂+♀	I	22	34	56	15	15	3+15	9	9	3
40	21	♂+♀	I	24	32	56	14	16	3+14	8	8	3
41	21	♂+♀	I	22	34	56	13	15	3+15	9	9	3
42	21	♂+♀	I	25	32	57	14	15	4+14	9	9	3
43	21	♂+♀	I	24	33	57	15	16	3+14	9	9	3
44	21	♂+♀	I	26	31	57	15	15	3+14	9	9	3r
45	21	♂+♀	I	25	32	57	16	15	3+14	9	9	3r
46	21	♂+♀	I	23	34	57	16	16	3+14	9	9	2
47	21	♂+♀	I	23	33	56	15	15	?	9	9	?
48	21	♂+♀	I	23	34	57	16	15	3+16	9	8	3r
49	21	♂+♀	I	26	32	58	14	15	4+13	9	9	4
50	21	♂+♀	I	25	32	57	13	15	3+16	9	9	4r
51	21	♂+♀	I	24	33	57	16	16	3+13	9	9	3r
52	21	♂+♀	I	23	34	57	14	15	3+15	9	9	3r
53	21	♂+♀	I	23	33	56	14	15	3+15	9	9	3r
54	21	♂+♀	I	24	33	57	14	14	3+14	9	9	3
55	21	♂+♀	I	23	34	57	15	15	3+14	8	8	4
56	21	♂+♀	I	24	33	57	15	16	3+14	9	9	3
57	21	♂+♀	I	24	33	57	14	16	3+14	9	9	3r
58	21	♂+♀	I	24	33	57	13	14	3+14	9	9	3r
59	20	♂+♀	I	24	32	56	15	15	3+13	8	8	4
60	20	♂+♀	I	24	33	57	16	16	3+14	9	9	3
61	20	♂+♀	I	23	33	56	15	14	3+13	9	9	3r
62	20	♂+♀	I	23	34	57	13	14	3+14	9	9	5
63	20	♂+♀	I	24	33	57	14	15	3+14	9	9	3r
64	20	♂+♀	I	24	32	56	14	15	3+15	9	9	3r
65	20	♂+♀	I	24	32	56	15	15	3+13	9	9	3
66	20	♂+♀	I	25	32	57	14	16	3+14	9	9	3
67	20	♂+♀	I	23	34	57	16	15	3+16	9	9	4r
68	20	♂+♀	I	27	30	57	16	15	?	8	8	3r
69	20	♂+♀	I	23	33	56	16	15	3+13	8	8	3
70	20	♂+♀	I	24	32	56	15	15	3+15	9	8	3r
71	20	♂+♀	I	23	34	57	14	15	3+13	9	9	4
72	20	♂+♀	I	25	33	58	15	16	3+14	9	9	3r
73	20	♂+♀	I	25	31	56	15	15	3+15	8	8	3r
74	20	♂+♀	I	24	34	58	16	15	4+15	8	9	3r
75	20	♂+♀	I	23	33	56	14	16	3+15	9	9	3
76	20	♂+♀	I	23	34	57	14	15	3+15	9	9	?
77	20	♂+♀	I	25	32	57	15	16	3+14	9	8	3r
78	20	♂+♀	I	24	33	57	16	14	3+14	9	9	3
79	20	♂+♀	I	24	33	57	14	16	3+15	8	9	5
80	20	♂+♀	I	25	31	56	14	15	3+14	8	8	?

No.	Length cm	Sex	Maturity	Vertebrae			Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventr. fins		No. of winter-rings in scales approxim.
				Pre-caudal	Caudal	Total				right	left	
81	19	♂+♀	I	24	33	57	15	15	3+16	9	9	2r?
82	19	♂+♀	I	25	32	57	15	15	4+13	9	9	4
83	19	♂♂+♀	I	24	32	56	14	16	3+15	9	9	5
84	19	♂♂+♀	I	28	29	57	15	15	3+14	9	9	3r
85	19	♂♂+♀	I	24	33	57	15	15	3+15	9	9	2
86	19	♂♂+♀	I	23	33	56	15	15	3+14	9	9	3
87	19	♂♂+♀	I	24	33	57	15	16	3+14	9	9	3
88	19	♂♂+♀	I	23	32	55	15	15	3+14	9	9	3r
89	19	♂♂+♀	I	23	33	56	15	16	3+14	9	9	3r
90	19	♂+♀	I	23	33	56	17	13	3+13	9	9	4
91	19	♂♂+♀	I	23	33	56	15	15	3+15	9	9	3r
92	19	♂♂+♀	I	23	34	57	14	17	3+14	8	8	3
93	19	♂♂+♀	I	25	32	57	14	15	3+15	9	9	4r
94	19	♂♂+♀	I	24	34	58	15	16	3+14	9	9	3r
95	19	♂♂+♀	I	23	33	56	15	15	3+15	9	9	3r
96	19	♂♂+♀	I	24	31	55	13	16	3+14	9	9	3r
97	19	♂♂+♀	I	24	33	57	14	14	3+13	8	9	3r
98	19	♂♂+♀	I	24	33	57	15	16	4+15	9	9	3r
99	19	♂♂+♀	I	24	33	57	14	16	3+14	9	9	3r
100	18	♂+♀	I	24	33	57	14	15	3+15	9	9	3r
101	18	♂+♀	I	24	32	56	15	16	3+14	9	9	2
102	18	♂♂+♀	I	23	33	56	15	14	4+13	9	9	3
103	18	♂♂+♀	I	23	34	57	16	15	3+15	9	9	3r?
104	18	♂♂+♀	I	23	32	55	15	15	3+15	9	8	2r
105	18	♂♂+♀	I	27	29	56	13	15	3+14	9	9	2r
106	18	♂♂+♀	I	25	32	57	15	15	3+14	9	9	3
107	18	♂♂+♀	I	23	33	56	16	15	3+15	9	9	2r
108	18	♂♂+♀	I	24	33	57	15	15	3+14	9	9	2r
109	18	♂♂+♀	I	24	32	56	13	16	3+14	9	9	2r?
110	18	♂♂+♀	I	24	32	56	14	15	3+15	9	9	3r
111	18	♂♂+♀	I	24	33	57	15	15	3+15	8	8	2r
112	18	♂♂+♀	I	24	32	56	14	15	3+16	9	9	?
113	18	♂♂+♀	I	25	32	57	15	15	3+14	9	9	2r
114	18	♂♂+♀	I	23	33	56	15	15	3+15	9	9	2r
115	18	♂♂+♀	I	24	34	58	15	15	3+14	9	9	?
116	17	♂♂+♀	I	23	33	56	14	15	3+13	9	9	2r
117	17	♂♂+♀	I	24	33	57	14	16	3+14	8	8	2
118	17	♂♂+♀	I	23	34	57	14	15	4+13	8	9	3?
119	16	♂♂+♀	I	24	33	57	15	15	3+15	9	9	3
120	16	♂+♀	I	24	33	57	16	16	?	9	9	4r

No.	Length cm	Sex	Maturity	Vertebrae			Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventr. fins		No. of winter-rings in scales approxim.
				Pre-caudal	Caudal	Total				right	left	
1	22.0	♂	I-II	23	33	56	15	14	3+14	9	9	5r
2	21.2	♂♂+♀	I-II	25	32	57	13	15	3+15	9	9	3r
3	22.8	♂♀	I-II	26	30	56	17	16	3+14	9	8	3r
4	22.0	♂♀	I-II	24	32	56	14	15	3+14	9	9	3r
5	22.5	♂♀	I-II	24	33	57	14	16	4+15	9	9	3
6	22.0	♂♀	I-II	23	34	57	16	15	3+15	9	9	5r
7	23.2	♂♀	I-II	24	33	57	14	15	3+14	9	9	3r?
8	22.3	♂♂♀	I-II	23	33	56	15	15	3+14	9	9	4r
9	20.7	♂♂♀	I-II	24	32	56	15	15	4+14	9	9	?
10	23.2	♂♂♀	I-II	23	34	57	14	15	3+15	9	9	3r
11	20.7	♂♂♀	I-II	25	31	56	15	16	3+14	9	9	3r
12	21.7	♂♀	I-II	24	32	56	15	16	3+14	9	9	3r
13	23.4	♂♀	I-II	23	33	56	16	15	3+13	8	8	3r
14	22.4	♂♀	I-II	23	33	56	15	14	3+13	9	9	4r
15	20.8	♂♀	I-II	24	34	58	15	15	3+14	9	9	4r
16	22.3	♂♀	I-II	23	33	56	16	15	3+14	9	9	4r?
17	22.5	♂♀	I-II	23	33	56	15	15	3+16	9	9	3
18	23.5	♂♀	I-II	24	32	56	14	16	4+14	9	9	3r
19	21.7	♂♀	I-II	23	33	56	14	15	3+13	9	8	4r
20	22.1	♂♀	I-II	24	33	57	13	15	3+15	8	9	4r
21	21.7	♂♀	I-II	23	33	56	16	15	3+14	9	9	4r
22	22.2	♂♀	I-II	25	32	57	15	16	3+15	7	10	3r
23	21.5	♂♀	I-II	23	33	56	15	15	3+14	9	9	4r
24	23.5	♀	I-II	25	32	57	15	15	3+13	9	9	3r
25	24.1	♀	I-II	24	33	57	14	16	3+15	9	9	3r
26	21.3	♂♀	I-II	24	33	57	14	15	3+15	9	9	3?
27	23.2	♂♀	I-II	23	33	56	16	15	3+15	9	9	3r
28	22.4	♂♀	I-II	23	35	58	14	15	3+14	9	9	3
29	22.8	♂♀	I-II	23	34	57	14	15	3+14	9	9	4
30	22.1	♂♀	I-II	24	32	56	14	15	3+13	9	8	5r
31	22.5	♂♂♀	I-II	24	33	57	15	16	?	9	9	3
32	22.0	♂♂♀	I-II	22	34	56	15	16	3+13	9	9	4r
33	22.1	♂♂♀	I-II	24	33	57	16	15	3+14	8	9	4
34	22.5	♂♀	I-II	24	33	57	15	15	3+14	8	8	3r
35	22.1	♂♀	I-II	25	31	56	15	14	3+14	9	9	5r?
36	21.9	♂♂♀	I-II	23	34	57	14	16	3+13	8	9	3
37	22.3	♂♀	I-II	23	34	57	15	16	3+16	9	8	3r?
38	21.5	♂♀	I-II	24	33	57	15	16	3+13	9	9	3
39	22.0	♂♀	I-II	23	33	56	14	15	3+14	9	9	2
40	21.3	♂♀	I-II	23	33	56	15	15	3+13	8	9	4r
41	23.3	♂♂♀	I-II	23	33	56	16	?	3+13	9	9	4r
42	23.2	♂♀	I-II	23	34	57	14	16	4+14	9	9	6r
43	22.2	♂♀	I-II	24	33	57	15	16	3+14	9	9	3
44	22.6	♂♀	I-II	24	34	58	15	?	?	8	8	3
45	23.0	♂♀	I-II	24	32	56	14	15	4+13	9	9	4
46	21.4	♂♀	I-II	25	32	57	15	15	3+14	9	9	3

No.	Length cm	Sex	Maturity	Vertebrae			Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventr. fins		No. of winter-rings in scales approxim.
				Pre-caudal	Caudal	Total				right	left	
1	18.6	♀	II	26	30	56	14	16	3+15	9	9	2r
2	19.5	♀	II	24	33	57	15	15	3+15	9	9	3r
3	22.5	♀	II	24	34	58	14	?	3+13	9	9	3
4	21.3	♀	II	24	32	56	16	15	3+13	9	9	2r
5	17.2	♀	II	23	34	57	15	15	4+13	8	8	4r
6	19.2	♀	II	24	33	57	14	15	3+15	9	9	3r
7	22.3	♀	II	24	33	57	14	14	4+15	9	9	3r
8	18.5	♀	II	25	31	56	15	14	3+16	9	8	3r
9	22.3	♀	II	25	31	56	13	15	3+15	9	9	3r
10	22.2	♀	II	25	32	57	14	16	3+16	9	9	4r
11	19.4	♀	II	24	33	57	14	16	3+14	9	9	?
12	21.6	♀	II	24	32	56	14	15	3+14	9	8	4r
13	19.2	♀	II	23	33	56	16	14	3+14	8	8	3r
14	23.0	♀	II	23	34	57	14	16	3+13	9	9	3(r)
15	22.5	♀	II	24	32	56	14	16	?	9	8	3r
16	22.2	♀	II	24	33	57	14	15	3+15	9	9	3r
17	21.6	♀	II	25	32	57	15	16	4+14	9	9	4r
18	21.6	♀	II	23	33	56	14	?	3+14	?	9	4r
19	24.0	♀	II	23	33	56	13	15	3+15	9	9	?
20	19.2	♀	II	23	34	57	15	15	3+14	9	9	3r
21	22.5	♀	II	24	34	58	14	15	3+14	9	9	3r
22	23.0	♀	II	24	32	56	14	15	3+16	9	9	3r
23	21.5	♀	II	24	33	57	14	15	3+15	9	9	3
24	20.0	♀	II	23	33	56	15	15	4+14	8	8	3r
25	20.6	♀	II	23	32	55	12	15	3+15	9	9	4r
26	21.5	♀	II	23	34	57	14	15	3+15	8	8	?
27	20.2	♀	II	25	31	56	15	16	4+15	9	9	3
28	24.3	♀	II	23	35	58	15	16	3+15	9	9	3
29	18.5	♀	II	24	32	56	15	15	3+13	9	9	3
30	21.3	♀	II	23	33	56	14	16	3+14	9	9	3r
31	22.0	♀	II	26	31	57	15	15	3+14	9	9	6r
32	22.2	♀	II	24	33	57	15	16	3+16	9	9	4r
33	21.2	♀	II	23	33	56	14	15	3+15	9	9	3
34	19.1	♀	II	23	33	56	16	15	3+13	9	9	2
35	22.3	♀	II	24	33	57	14	16	4+14	9	9	4r
36	21.7	♀	II	24	32	56	14	15	3+14	9	9	4r
37	22.6	♀	II	25	31	56	16	15	3+15	8	8	4r
38	20.3	♀	II	24	32	56	16	16	3+14	8	8	4r
39	24.3	♀	II	24	33	57	14	16	3+15	9	9	4r
40	19.2	♀	II	23	34	57	14	16	3+14	9	9	2r
41	22.0	♀	II	24	32	56	17	16	3+13	8	8	4r
42	23.6	♀	II	24	32	56	13	16	3+15	9	9	4r
43	19.0	♀	II	23	33	56	16	16	3+14	9	9	4r
44	21.6	♀	II	24	33	57	15	14	3+13	9	9	4
45	21.6	♀	II	24	33	57	14	15	3+15	9	9	3r
46	20.2	♀	II	23	33	56	15	16	3+15	9	9	4r

No.	Length cm	Sex	Maturity	Vertebrae: Pre-caudal	Vertebrae: Caudal	Vertebrae: Total	Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventr. fins: right	Rays in ventr. fins: left	No. of winter-rings in scales approxim.
47	21.7	♂♂♂♂♀♀♀	II	24	33	57	15	16	3+16	9	9	3
48	18.5	♂♂♂♂♀♀♀	II	23	33	56	14	?	?	9	9	4r
49	23.2	♂♂♂♂♂♂♂	II	23	34	57	15	16	?+16	8	8	4r
50	21.5	♂♂♂♂♂♂♂	II	24	33	57	15	15	3+14	9	9	4
51	21.5	♂♂♂♂♂♂♂	II	25	31	56	16	?	3+13	9	9	4r
52	23.3	♂♂♂♂♂♂♂	II	25	33	58	13	15	3+15	9	9	3
53	20.5	♂♂♂♂♂♂♂	II	25	32	57	15	15	3+15	9	9	3
54	21.9	♂♂♂♂♂♂♂	II	23	33	56	13	15	3+15	9	9	4r?
55	22.5	♂♂♂♂♂♂♂	II	24	33	57	15	16	3+15	9	9	3
56	23.7	♂♂♂♂♂♂♂	II	25	32	57	14	15	3+14	9	9	3r
57	21.8	♂♂♂♂♂♂♂	II	24	32	56	14	15	3+16	9	9	4r
58	22.6	♂♂♂♂♂♂♂	II	24	32	56	14	15	3+16	9	9	3r
59	19.8	♂♂♂♂♂♂♂	II	24	32	56	14	15	3+14	9	9	3r
60	22.9	♂♂♂♂♂♂♂	II	24	32	56	16	16	3+14	9	9	5r
61	23.1	♂♂♂♂♂♂♂	II	24	33	57	14	15	3+15	9	9	3r
62	23.3	♂♂♂♂♂♂♂	II	24	34	58	14	16	4+15	9	9	3r
63	22.0	♂♂♂♂♂♂♂	II	24	34	58	14	15	3+15	9	9	4r
64	23.6	♂♂♂♂♂♂♂	II	23	33	56	14	?	3+14	9	9	3r
65	21.0	♂♂♂♂♂♂♂	II	23	34	57	14	16	3+14	9	9	3r
66	23.5	♂♂♂♂♂♂♂	II	22	34	56	15	15	3+15	9	9	4r
67	22.4	♂♂♂♂♂♂♂	II	23	34	57	15	16	3+15	9	9	3r
68	22.4	♂♂♂♂♂♂♂	II	24	33	57	14	16	3+15	9	9	4r
69	22.7	♂♂♂♂♂♂♂	II	24	33	57	14	15	4+14	9	9	3
70	21.0	♂♂♂♂♂♂♂	II	23	34	57	15	15	2+14	9	9	3r
71	22.8	♂♂♂♂♂♂♂	II	23	33	56	14	15	3+14	9	9	3r
72	22.5	♂♂♂♂♂♂♂	II	26	33	59	14	15	3+15	9	9	3r
73	20.7	♂♂♂♂♂♂♂	II	24	32	56	14	15	3+13	9	9	4r
74	23.2	♂♂♂♂♂♂♂	II	24	32	56	14	15	3+14	9	9	3r
75	22.4	♂♂♂♂♂♂♂	II	24	33	57	14	16	3+14	9	9	3r
76	22.7	♂♂♂♂♂♂♂	II	23	34	57	13	16	3+15	9	9	4r
77	21.7	♂♂♂♂♂♂♂	II	24	33	57	14	15	3+16	9	9	3r
78	23.0	♂♂♂♂♂♂♂	II	26	31	57	13	16	3+16	9	9	3r
79	20.0	♂♂♂♂♂♂♂	II	24	33	57	14	15	3+15	9	9	3
80	20.5	♂♂♂♂♂♂♂	II	24	32	56	14	16	3+14	9	8	3r
81	22.3	♂♂♂♂♂♂♂	II	25	33	58	14	15	3+16	9	9	4r
82	24.8	♂♂♂♂♂♂♂	II	25	32	57	14	14	?	9	9	3r
83	22.9	♂♂♂♂♂♂♂	II	24	33	57	14	15	3+16	9	9	3r
84	21.8	♂♂♂♂♂♂♂	II	23	34	57	13	?	3+15	9	9	3r
85	24.0	♂♂♂♂♂♂♂	II	24	33	57	14	16	3+16	9	9	3r
86	22.4	♂♂♂♂♂♂♂	II	24	32	56	16	16	3+13	7	7	4r
87	22.1	♂♂♂♂♂♂♂	II	24	34	58	13	16	3+16	9	9	4r
88	23.2	♂♂♂♂♂♂♂	II	23	34	57	13	?	3+15	9	9	4r
89	23.5	♂♂♂♂♂♂♂	II	25	32	57	14	16	3+13	9	9	3r
90	22.0	♂♂♂♂♂♂♂	II	24	33	57	15	16	3+14	8	8	3r?
91	19.0	♂♂♂♂♂♂♂	II	23	33	56	14	15	3+14	8	8	3
92	22.7	♂♂♂♂♂♂♂	II	23	33	56	15	?	3+15	8	8	3r
93	23.5	♂♂♂♂♂♂♂	II	24	33	57	16	15	3+15	8	9	3r
94	23.4	♂♂♂♂♂♂♂	II	23	33	56	15	15	3+14	8	8	3
95	20.2	♂♂♂♂♂♂♂	II	24	32	56	15	15	?	9	?	3
96	20.9	♂♂♂♂♂♂♂	II	23	34	57	15	15	3+13	9	9	4?
97	21.8	♂♂♂♂♂♂♂	II	24	32	56	13	16	3+14	?	?	4r
98	22.2	♂♂♂♂♂♂♂	II	24	33	57	15	15	3+13	10	9	3r
99	22.7	♂♂♂♂♂♂♂	II	24	33	57	15	15	?	8	8	3r
100	22.5	♂♂♂♂♂♂♂	II	24	33	57	14	14	3+14	9	9	3r

b. Spring Spawners. Maturity III.—V.

No.	Length cm	Sex	Maturity	Vertebrae: Pre-caudal	Vertebrae: Caudal	Vertebrae: Total	Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventr. fins: right	Rays in ventr. fins: left	No. of winter-rings in scales approxim.
1	20.5	♂♂♂♂♂♂♂	III	23	33	56	13	15	3+12	9	9	3r
2	24.0	♂♂♂♂♂♂♂	III	24	34	58	14	15	4+14	9	9	5r
3	23.4	♂♂♂♂♂♂♂	III	24	33	57	13	15	3+15	8	9	4
4	23.2	♂♂♂♂♂♂♂	III	24	33	57	15	15	3+14	9	9	4r
5	22.0	♂♂♂♂♂♂♂	III	24	33	57	15	15	3+14	9	9	4r
6	24.3	♂♂♂♂♂♂♂	III	23	33	56	14	15	4+15	9	9	3r
7	22.1	♂♂♂♂♂♂♂	III	25	32	57	14	15	4+14	9	9	3r?
8	22.9	♂♂♂♂♂♂♂	III	23	33	56	14	16	3+15	9	9	4r
9	23.0	♂♂♂♂♂♂♂	III	22	33	55	16	16	3+14	9	9	6r
10	21.8	♂♂♂♂♂♂♂	III	24	33	57	15	16	3+14	8	8	3r
11	22.0	♂♂♂♂♂♂♂	III	24	32	56	14	14	3+15	9	9	3r?
12	21.7	♂♂♂♂♂♂♂	III	23	33	56	13	15	3+14	9	9	3r
13	20.8	♂♂♂♂♂♂♂	III	24	30	54	14	15	3+14	9	9	4r
14	22.4	♂♂♂♂♂♂♂	III	24	31	55	15	15	4+14	9	9	4r
15	19.5	♂♂♂♂♂♂♂	III	24	31	55	13	15	3+14	9	9	3r
16	23.5	♂♂♂♂♂♂♂	III	25	32	57	14	15	4+14	9	9	3r
17	23.7	♂♂♂♂♂♂♂	III	24	32	56	13	16	3+15	9	9	3r
18	24.5	♀♀♀♀♀♀♀	III	24	32	56	14	16	3+14	9	9	3r
19	22.4	♀♀♀♀♀♀♀	III	23	32	55	14	15	3+13	9	9	3r
20	24.1	♀♀♀♀♀♀♀	III	26	32	58	14	16	3+15	9	9	4r
21	23.6	♀♀♀♀♀♀♀	III	24	33	57	14	15	3+16	9	9	3r
22	21.3	♀♀♀♀♀♀♀	III	23	33	56	15	14	3+14	9	9	4r
23	22.2	♀♀♀♀♀♀♀	III	23	33	56	15	?	3+13	9	?	3r
24	23.0	♀♀♀♀♀♀♀	III	24	32	56	13	16	3+15	9	9	3r
25	23.6	♀♀♀♀♀♀♀	III	23	34	57	14	15	4+15	9	9	3r?
26	22.3	♀♀♀♀♀♀♀	III	24	34	58	14	16	?	9	9	3r
27	23.6	♀♀♀♀♀♀♀	III	23	33	56	14	15	3+14	9	9	3r
28	23.5	♀♀♀♀♀♀♀	III	25	33	58	13	14	3+16	9	9	3r
29	22.3	♀♀♀♀♀♀♀	III	24	32	56	13	16	3+15	9	9	4r?
30	21.5	♀♀♀♀♀♀♀	III	25	32	57	15	?	3+14	9	9	..
31	22.5	♀♀♀♀♀♀♀	III	25	33	58	14	16	3+14	9	9	3r
32	22.5	♀♀♀♀♀♀♀	III	22	34	56	15	?	3+14	9	9	3r
33	23.0	♀♀♀♀♀♀♀	III	25	32	57	14	15	3+15	9	9	3r?
34	23.0	♀♀♀♀♀♀♀	III	24	32	56	14	15	3+14	9	9	3r
1	21.0	♂♂♂♂♂♂♂	IV	23	32	55	15	14	4+13	8	9	4r
2	22.1	♂♂♂♂♂♂♂	IV	25	30	55	14	15	4+13	9	9	3r
3	23.9	♂♂♂♂♂♂♂	IV	26	31	57	14	15	4+14	9	9	3r
4	21.4	♂♂♂♂♂♂♂	IV	25	31	56	13	15	3+15	9	9	3r?
5	23,6	♂♂♂♂♂♂♂	IV	24	32	56	15	15	3+15	9	9	3r
6	22.2	♂♂♂♂♂♂♂	IV	23	34	57	13	15	3+14	9	9	3r
7	21.6	♂♂♂♂♂♂♂	IV	23	32	55	13	15	4+14	9	9	4r
8	23.6	♂♂♂♂♂♂♂	IV	25	33	58	15	15	4+14	9	9	4r
9	21.1	♂♂♂♂♂♂♂	IV	24	31	55	14	15	3+14	9	9	3r
10	20.6	♂♂♂♂♂♂♂	IV	24	32	56	14	15	4+13	9	9	3r
11	21.4	♂♂♂♂♀♀♀	IV	23	33	56	15	15	3+14	9	9	4r
12	21.7	♂♂♂♂♀♀♀	IV	23	33	56	14	15	3+13	9	9	3r?
13	21.8	♂♂♂♂♀♀♀	IV	23	31	54	13	15	3+13	9	9	3r?
14	24.1	♂♂♂♂♀♀♀	IV	25	32	57	13	15	3+15	9	9	4r
15	22.0	♂♂♂♂♀♀♀	IV	23	31	54	13	15	3+14	9	9	4r
16	22.5	♂♂♂♂♀♀♀	IV	24	33	57	14	15	3+13	9	9	5–6
17	21.4	♂♂♂♂♀♀♀	IV	23	33	56	14	15	3+13	9	9	3r?
18	21.7	♂♂♂♂♀♀♀	IV	23	34	57	14	15	3+13	9	9	4r
19	23.1	♂♂♂♂♀♀♀	IV	23	35	58	14	15	3+16	9	9	3r
1	22.6	♂♂♂♂♂♂♂	V	24	32	56	13	14	3+14	9	9	3r
2	24.3	♂♂♂♂♂♂♂	V	25	33	58	13	15	3+15	9	9	3r
3	23.3	♂♂♂♂♂♂♂	V	24	32	56	15	15	3+15	9	9	3r
4	22.0	♂♂♂♂♂♂♂	V	23	32	55	13	15	4+13	9	9	4r?
5	21.3	♂♂♂♂♂♂♂	V	25	32	57	14	14	2+15	9	9	3r
6	22.4	♂♂♂♂♂♂♂	V	23	33	56	15	15	3+14	7	8	3?
7	23.0	♂♂♂♂♂♂♂	V	23	33	56	15	15	3+14	9	9	3
8	23.2	♂♂♂♂♂♂♂	V	23	32	55	15	15	3+13	9	9	4r
9	21.7	♂♂♂♂♂♂♂	V	22	32	54	15	15	3+15	9	9	3r
10	24.1	♂♂♂♂♂♂♂	V	25	32	57	14	16	4+14	9	9	4r
11	20.5	♂♂♂♂♂♂♂	V	22	33	55	14	14	3+12	9	9	4r
12	21.1	♂♂♂♂♀♀♀	V	25	32	57	15	16	3+13	9	9	3r

c. Autumn Spawners. Recovering spents Maturity VIII.

No.	Length cm	Sex	Maturity	Vertebrae			Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins		No. of winter-rings in scales approxim.
				Pre-caudal	Caudal	Total				right	left	
1	24.2	♂	VIII	24	33	57	15	15	3+15	9	9	5
2	23.7	♂	VIII	23	34	57	16	15	3+14	8	8	6r
3	23.0	♂	VIII	23	33	56	14	15	3+14	9	8	3
4	23.2	♂	VIII	23	33	56	16	16	3+15	9	9	4r?
5	26.6	♂	VIII	23	33	56	16	16	3+14	9	9	5r
6	25.6	♂	VIII	24	33	57	15	16	2+15	9	9	4r
7	28.4	♂	VIII	24	32	56	15	15	3+14	9	9	4r
8	26.1	♂	VIII	24	32	56	15	15	3+14	9	9	6r
9	24.0	♂	VIII	24	32	56	15	16	3+14	9	9	4r
10	26.5	♂	VIII	25	33	58	15	15	3+17	9	10	6
11	26.7	♂	VIII	24	33	57	15	15	3+14	9	8	6
12	27.0	♂	VIII	23	33	56	16	16	?	9	9	4
13	23.4	♂	VIII	28	29	57	15	15	3+13	9	9	5
14	21.6	♂	VIII	24	33	57	16	17	3+15	9	9	4
15	25.1	♂	VIII	25	32	57	15	15	3+13	9	8	5
16	26.9	♂	VIII	22	33	55	16	15	4+14	9	9	6
17	26.3	♂	VIII	24	32	56	15	15	3+15	9	9	6r
18	27.4	♂	VIII	25	32	57	15	16	3+13	9	9	6
19	24.6	♂	VIII	24	32	56	15	14	3+15	9	9	4r
20	26.0	♂	VIII	24	33	57	15	16	3+13	8	8	5
21	22.8	♂	VIII	24	33	57	14	16	3+14	9	9	4r
22	23.9	♂	VIII	24	32	56	13	14	3+15	9	9	5r
23	24.9	♂	VIII	23	34	57	15	16	4+14	9	9	4
24	24.6	♂	VIII	25	32	57	14	15	3+13	9	9	4r
25	22.2	♂	VIII	23	33	56	15	15	3+14	10	9	5
26	26.4	♂	VIII	26	30	56	15	14	3+14	9	9	7r
27	22.2	♂	VIII	24	31	55	17	15	3+13	9	9	4
28	26.6	♂	VIII	24	32	56	13	15	3+13	9	8	5
29	25.9	♂	VIII	23	33	56	15	14	3+15	9	9	5r
30	29.2	♂	VIII	24	32	56	14	16	3+14	9	9	6
31	23.4	♂	VIII	24	32	56	15	16	3+15	9	9	3r
32	26.5	♂	VIII	24	33	57	15	16	3+14	9	9	4
33	21.2	♂	VIII	23	32	55	14	14	3+12	8	8	3
34	24.3	♂	VIII	23	33	56	15	15	3+15	9	9	5
35	24.9	♂	VIII	24	33	57	15	16	3+17	9	9	4?
36	23.1	♂	VIII	23	33	56	15	15	3+14	8	8	5r
37	26.5	♂	VIII	23	33	56	16	16	4+14	9	9	5r
38	25.0	♂	VIII	22	34	56	14	15	3+13	9	9	5
39	22.6	♂	VIII	24	33	57	16	15	2+14	9	9	4
40	25.5	♂	VIII	24	32	56	15	15	3+15	9	9	5
41	23.0	♂	VIII	22	33	55	15	15	?	7	7	5
42	22.8	♂	VIII	23	33	56	14	15	3+14	9	9	4
43	25.5	♂	VIII	24	32	56	16	15	2+13	9	9	6
44	22.3	♂	VIII	24	33	57	16	15	3+15	9	9	5
45	26.2	♂	VIII	23	33	56	15	16	3+14	9	9	6?
46	23.2	♂	VIII	24	32	56	15	16	3+14	9	9	5r
47	21.7	♂	VIII	24	31	55	15	13	4+13	9	9	5
48	22.0	♂	VIII	23	32	55	15	15	3+13	9	9	4
49	22.0	♂	VIII	24	33	57	15	15	3+13	8	8	4r
50	23.9	♂	VIII	23	33	56	14	15	3+14	9	9	3
51	23.4	♀	VIII	23	33	56	15	15	3+14	9	9	4r
52	24.4	♀	VIII	24	33	57	15	15	3+13	9	9	4—5
53	27.2	♀	VIII	23	34	57	17	16	3+14	8	8	c. 8
54	21.2	♀	VIII	23	33	56	15	?	3+14	8	8	4
55	28.1	♀	VIII	24	32	56	15	?	3+13	9	9	4—6
56	21.2	♀	VIII	23	34	57	16	16	?	9	9	5
57	24.1	♀	VIII	23	33	56	15	15	3+15	9	9	4—5
58	25.3	♀	VIII	24	32	56	15	15	4+14	9	9	5
59	28.5	♀	VIII	23	34	57	14	15	3+14	9	9	11
60	24.0	♀	VIII	23	33	56	14	16	3+14	9	9	5r
61	25.5	♀	VIII	23	33	56	14	16	3+14	9	9	5
62	24.5	♀	VIII	22	34	56	14	15	4+12	9	9	5
63	27.5	♀	VIII	24	32	56	16	15	3+14	8	8	6r
64	23.2	♀	VIII	23	34	57	15	15	3+14	9	9	4r
65	25.6	♀	VIII	23	32	55	14	14	3+15	8	8	5
66	26.5	♀	VIII	23	33	56	17	15	3+16	9	9	5r
67	21.4	♀	VIII	24	32	56	15	15	3+14	9	9	4r
68	23.6	♀	VIII	24	32	56	16	16	3+13	8	8	5r
69	23.2	♀	VIII	23	33	56	16	16	?	9	9	4r
70	26.2	♀	VIII	25	32	57	15	15	4+14	9	9	6r
71	22.7	♀	VIII	23	34	57	14	16	3+15	9	9	4r
72	22.0	♀	VIII	25	31	56	16	14	3+14	9	9	5
73	24.2	♀	VIII	24	32	56	13	16	3+15	9	9	3
74	22.6	♀	VIII	23	33	56	?	15	3+13	7	8	4
75	25.6	♀	VIII	25	32	57	15	15	3+14	9	9	5r
76	26.2	♀	VIII	25	32	57	14	15	3+14	9	9	5
77	26.5	♀	VIII	24	33	57	15	15	3+13	9	9	5
78	29.3	♀	VIII	24	33	57	14	16	3+14	9	9	8
79	22.2	♀	VIII	22	34	56	14	?	3+15	9	9	4
80	27.2	♀	VIII	24	33	57	15	16	4+12	9	9	6
81	27.8	♀	VIII	24	33	57	15	15	3+14	9	9	5
82	22.0	♀	VIII	25	31	56	15	14	3+13	9	9	4
83	27.1	♀	VIII	23	33	56	14	15	3+13	9	9	3
84	23.9	♀	VIII	24	33	57	14	15	3+15	9	9	5r
85	22.5	♀	VIII	23	33	56	15	16	3+13	8	8	4r
86	26.6	♀	VIII	23	33	56	14	16	3+15	9	9	3
87	24.5	♀	VIII	24	32	56	15	14	3+16	9	9	5
88	27.0	♀	VIII	23	33	56	15	16	3+16	9	9	6r
89	27.5	♀	VIII	24	32	56	14	14	3+15	9	9	5
90	24.1	♀	VIII	24	33	57	14	14	3+14	9	9	4
91	23.6	♀	VIII	24	32	56	15	16	3+13	9	9	6r
92	25.0	♀	VIII	24	33	57	15	16	3+15	8	8	4
93	24.0	♀	VIII	24	32	56	14	?	3+13	9	9	5
94	27.9	♀	VIII	26	31	57	16	15	3+14	9	9	8
95	22.1	♀	VIII	23	34	57	17	15	3+13	9	9	4
96	23.2	♀	VIII	24	34	58	16	17	3+16	9	7	4
97	25.4	♀	VIII	24	33	57	14	16	3+14	9	9	3
98	22.2	♀	VIII	23	33	56	15	15	?	9	9	4 -5
99	22.0	♀	VIII	24	33	57	15	16	3+15	9	9	3r
100	25.0	♀	VIII	23	33	56	14	16	3+13	8	9	4
101	21.7	♂	VIII	24	32	56	15	15	3+12	9	9	4r
102	23.8	♂	VIII	22	35	57	16	16	3+14	9	9	3
103	23.1	♂	VIII	23	33	56	15	15	3+13	8	8	4r
104	24.5	♂	VIII	23	33	56	15	14	3+14	9	9	4
105	20.9	♂	VIII	24	33	57	14	14	4+12	9	8	4r
106	24.2	♂	VIII	22	32	54	15	17	3+14	8	8	4
107	21.5	♂	VIII	23	34	57	15	15	3+14	9	9	3
108	22.8	♂	VIII	24	32	56	14	16	3+15	9	9	3r
109	21.1	♂	VIII	25	32	57	16	15	3+13	9	9	12
110	22.3	♂	VIII	23	32	55	14	15	3+14	9	9	4
111	23.5	♂	VIII	23	34	57	17	15	3+14	9	9	4r
112	24.0	♂	VIII	23	33	56	16	15	3+13	9	9	3
113	22.7	♂	VIII	24	32	56	14	16	3+14	8	9	4
114	23.7	♂	VIII	24	33	57	15	15	3+15	9	10	3r
115	23.1	♀	VIII	24	34	58	15	15	3+16	8	9	4
116	20.6	♀	VIII	24	32	56	15	15	3+13	9	8	4
117	25.6	♂	VIII	22	34	56	15	16	3+15	9	9	4r
118	24.1	♀	VIII	25	31	56	15	15	3+14	9	9	6
119	25.0	♂	VIII	24	33	57	15	15	3+14	9	9	4
120	26.2	♀	VIII	24	32	56	14	16	3+14	9	9	6

D. Young Herrings from Lild Strand. E. of Hanstholm.

Aug. 23. 1921. Maturity I. Caught in Young Plaice Trawl.

No.	Length cm	Vertebrae			Keeled scales K_2	Rays in ventral fins		No. of winter-rings in scales	No.	Length cm	Vertebrae			Keeled scales K_2	Rays in ventral fins		No. of winter-rings in scales
		Pre-caudal	Caudal	Total		right	left				Pre-caudal	Caudal	Total		right	left	
1	9.6	22	35	57	15	9	6	0	9	9.0	24	32	56	15	9	9	0
2	10.3	25	32	57	14	9	9	0	10	10.5	23	33	56	14	8	9	0
3	9.5	24	33	57	14	9	9	0	11	8.6	23	32	55	?	8	8	0
4	9.7	24	32	56	16	9	9	0	12	9.1	23	33	56	15	9	9	0
5	10.2	23	34	57	15	9	9	0	13	9.5	24	32	56	14	9	9	0
6	9.8	24	32	56	13	9	9	0	14	9.4	24	33	57	14	9	9	0
7	9.8	22	34	56	15	9	9	0	15	9.7	24	33	57	15	9	9	0
8	11.1	24	32	56	14	9	9	0	16	8.8	22	34	56	16	9	9	0

E. Herrings from W. by S. of Vinga. (N. E. Kattegat).

Febr. 10. 1915. Caught in Purse Seine.

a. Spring Spawners Maturity III—IV.

No.	Length cm	Sex	Vertebrae			Keeled scales K_2	No.	Length cm	Sex	Vertebrae			Keeled scales K_2
			Pre-caudal	Caudal	Total					Pre-caudal	Caudal	Total	
1	22	♂	23	33	56	13	33	23	♂	24	32	56	15
2	22	♂	26	31	57	14	34	24	♂	24	33	57	15
3	25	♂	23	34	57	14	35	21	♂	23	33	56	16
4	21	♂	24	32	56	15	36	23	♀	25	33	58	13
5	22	♂	24	31	55	15	37	23	♀	24	32	56	13
6	25	♂	26	33	59	15	38	21	♀	24	32	56	14
7	21	♂	25	32	57	16	39	21	♀	23	33	56	14
8	21	♂	24	32	56	13	40	21	♀	25	31	56	14
9	22	♂	24	31	55	13	41	22	♀	23	33	56	14
10	22	♂	23	33	56	13	42	22	♀	23	32	55	14
11	24	♂	25	34	59	13	43	22	♀	25	30	55	14
12	20	♂	24	32	56	14	44	22	♀	24	33	57	14
13	22	♂	22	32	54	14	45	22	♀	24	33	57	14
14	22	♂	25	31	56	14	46	22	♀	23	33	56	14
15	22	♂	25	32	57	14	47	23	♀	24	32	56	14
16	22	♂	25	31	56	14	48	23	♀	25	31	56	14
17	22	♂	24	33	57	14	49	24	♀	25	31	56	14
18	22	♂	25	32	57	14	50	24	♀	24	32	56	14
19	22	♂	23	33	56	14	51	21	♀	24	32	56	15
20	22	♂	24	32	56	14	52	21	♀	25	31	56	15
21	22	♂	22	33	55	14	53	23	♀	24	32	56	15
22	22	♂	24	32	56	14	54	23	♀	24	33	57	15
23	23	♂	24	32	56	14	55	24	♀	23	32	55	15
24	23	♂	25	31	56	14	56	26	♀	24	32	56	15
25	24	♂	24	32	56	14	57	21	♀	23	33	56	16
26	27	♂	23	33	56	14	58	22	♀	22	34	56	16
27	21	♂	25	31	56	15	59	21	♀	25	33	58	13
28	22	♂	24	32	56	15	60	23	♀	24	31	55	13
29	22	♂	25	32	57	15	61	23	♀	24	32	56	14
30	22	♂	24	32	56	15	62	23	♀	23	32	55	14
31	22	♂	25	30	55	15	63	32	♀	25	33	58	14
32	23	♂	24	32	56	15	64	26	♀	25	33	58	15

b. Autumn Spawners. Maturity VIII.

No.	Length cm	Sex	Vertebrae			Keeled scales K_2	Rays in both ventral fins	No.	Length cm	Sex	Vertebrae			Keeled scales K_2	Rays in both ventral fins
			Pre-caudal	Caudal	Total						Pre-caudal	Caudal	Total		
1	22	♂	22	34	56	14	18	6	20	♂	24	34	58	14	17
2	24	♂	24	33	57	14	18	7	24	♂	24	32	56	15	18
3	24	♂	22	33	55	14	18	8	25	♂	24	33	57	15	18
4	25	♂	23	33	56	14	18	9	26	♂	23	33	56	15	18
5	28	♂	25	31	56	14	17	10	27	♂	25	32	57	15	16

No.	Length cm	Sex	Vertebrae			Keeled scales K_3	Rays in both ventral fins	No.	Length cm	Sex	Vertebrae			Keeled scales K_2	Rays in both ventral fins
			Pre-caudal	Caudal	Total						Pre-caudal	Caudal	Total		
11	21	♂	23	33	56	15	17	31	24	♀	23	33	56	15	18
12	27	♂	24	32	56	15	17	32	24	♀	24	32	56	15	18
13	17	♂	23	33	56	16	18	33	24	♀	25	32	57	15	18
14	21	♂	26	30	56	16	18	34	24	♀	25	32	57	15	18
15	23	♂	25	33	58	16	18	35	25	♀	26	33	59	15	18
16	25	♂	24	32	56	16	18	36	25	♀	23	34	57	15	18
17	27	♂	24	34	58	16	18	37	25	♀	24	33	57	15	18
18	21	♂	24	33	57	16	17	38	26	♀	26	30	56	15	18
19	27	♂	23	34	57	16	17	39	28	♀	24	34	58	15	18
20	27	♂	24	33	57	16	17	40	21	♀	23	33	56	15	16
21	21	♀	23	31	54	14	18	41	22	♀	24	32	56	15	16
22	23	♀	24	33	57	14	18	42	23	♀	24	31	55	15	17
23	23	♀	24	33	57	14	18	43	23	♀	25	31	56	15	17
24	24	♀	24	32	56	14	18	44	24	♀	24	32	56	15	17
25	26	♀	24	32	56	14	18	45	24	♀	23	34	57	16	18
26	29	♀	24	33	57	14	18	46	25	♀	24	32	56	16	18
27	22	♀	24	32	56	14	17	47	25	♀	24	32	56	16	18
28	25	♀	23	33	56	14	17	48	26	♀	24	32	56	16	18
29	22	♀	24	33	57	15	18	49	26	♀	24	32	56	16	18
30	24	♀	24	33	57	15	18								

F. Herrings from N. of Skagen.

March 17. 1915. Caught in Purse Seine.

a. Spring Spawners. Maturity III—IV.

No.	Length cm	Sex	Vertebrae			Keeled scales K_3	Rays in both ventral fins	No.	Length cm	Sex	Vertebrae			Keeled scales K_2	Rays in both ventral fins
			Pre-caudal	Caudal	Total						Pre-caudal	Caudal	Total		
1	23	♀	25	31	56	14	17	8	23	♂	23	33	56	15	17
2	20	♀	22	33	55	13	18	9	24	♂	23	32	55	14	18
3	22	♀	23	32	55	14	18	10	23	♂	24	32	56	13	18
4	21	♀	21	32	53	14	18	11	23	♂	24	32	56	14	18
5	24	♀	24	32	56	15	18	12	24	♂	23	32	55	15	17
6	21	♀	26	33	59	14	18	13	21	♂	22	33	55	15	18
7	24	♂	24	32	56	14	18								

b. Autumn Spawners. Maturity VIII.

No.	Length cm	Sex	Vertebrae			Keeled scales K_3	Rays in both ventral fins	No.	Length cm	Sex	Vertebrae			Keeled scales K_2
			Pre-caudal	Caudal	Total						Pre-caudal	Caudal	Total	
1	25	♂	23	34	57	14	18	18	24	♂	26	31	57	14
2	24	♀	23	33	56	14	18	19	24	♂	23	34	57	14
3	26	♀	24	33	57	16	18	20	24	♂	24	32	56	14
4	25	♂	23	32	55	14	18	21	24	♂	24	31	55	14
5	27[1])	♂	23	33	56	15	17	22	25	♂	25	32	57	14
6	25	♂	24	32	56	15	18	23	25	♂	23	33	56	14
7	25	♀	23	34	57	14	18	24	25	♂	24	32	56	14
8	25	♀	25	32	57	16	18	25	25	♂	25	32	57	14
9	25	♂	23	33	56	14	18	26	25	♂	22	34	56	14
10	25	♀	24	34	58	14	18	27	25	♂	25	31	56	14
11	25	♂	24	33	57	16	18	28	25	♂	24	33	57	14
12	27[1])	♂	23	32	55	15	17	29	26	♂	25	31	56	14
13	27[1])	♂	26	31	57	15	16	30	27	♂	26	31	57	14
14	27[2])	♂	23	33	56	15	18	31	27	♂	24	32	56	14
15	22	♂	23	33	56	13	..	32	21	♂	24	32	56	15
16	26	♂	24	31	55	13	..	33	22	♂	24	34	58	15
17	22	♂	24	33	57	14	..	34	23	♂	25	32	57	15

[1]) age 7 r.

[2]) age 8 r.

No.	Length cm	Sex	Vertebrae			Keeled scales K_2	No.	Length cm	Sex	Vertebrae		
			Pre-caudal	Caudal	Total					Pre-caudal	Caudal	Total
35	23	♂	24	32	56	15	109	24	♀	23	33	56
36	23	♂	23	34	57	15	110	24	♀	25	32	57
37	23	♂	25	32	57	15	111	24	♀	24	33	57
38	24	♂	24	32	56	15	112	24	♀	24	33	57
39	24	♂	24	33	57	15	113	24	♀	23	33	56
40	24	♂	25	31	56	15	114	24	♀	23	33	56
41	24	♂	25	31	56	15	115	24	♀	23	33	56
42	24	♂	25	31	56	15	116	24	♀	23	33	56
43	24	♂	24	32	56	15	117	24	♀	24	33	57
44	24	♂	23	33	56	15	118	24	♀	25	32	57
45	24	♂	24	32	56	15	119	24	♀	24	33	57
46	24	♂	24	33	57	15	120	25	♀	23	33	56
47	24	♂	23	32	55	15	121	25	♀	25	31	56
48	25	♂	24	33	57	15	122	25	♀	25	32	57
49	25	♂	25	31	56	15	123	25	♀	24	33	57
50	25	♂	25	32	57	15	124	25	♀	25	32	57
51	25	♂	25	33	58	15	125	25	♀	25	32	57
52	25	♂	24	33	57	15	126	25	♀	24	33	57
53	25	♂	24	32	56	15	127	25	♀	23	34	57
54	25	♂	24	33	57	15	128	25	♀	25	32	57
55	25	♂	24	33	57	15	129	25	♀	23	33	56
56	25	♂	24	32	56	15	130	25	♀	23	33	56
57	26	♂	24	33	57	15	131	25	♀	24	33	57
58	26	♂	24	32	56	15	132	25	♀	23	34	57
59	26	♂	25	32	57	15	133	25	♀	25	32	57
60	26	♂	25	32	57	15	134	25	♀	24	34	58
61	26	♂	25	32	57	15	135	25	♀	24	32	56
62	26	♂	24	32	56	15	136	25	♀	24	33	57
63	26	♂	25	33	58	15	137	25	♀	23	33	56
64	26	♂	24	33	57	15	138	25	♀	24	32	56
65	26	♂	23	34	57	15	139	25	♀	24	32	56
66	26	♂	24	33	57	15	140	25	♀	24	32	56
67	28	♂	25	31	56	15	141	25	♀	24	33	57
68	28	♂	25	31	56	15	142	26	♀	24	32	56
69	30	♂	24	34	58	15	143	26	♀	24	32	56
70	21	♂	23	32	55	16	144	26	♀	23	33	56
71	22	♂	24	32	56	16	145	26	♀	24	33	57
72	22	♂	25	31	56	16	146	26	♀	24	33	57
73	23	♂	23	33	56	16	147	26	♀	24	33	57
74	24	♂	24	34	58	16	148	26	♀	25	31	56
75	24	♂	24	33	57	16	149	26	♀	23	33	56
76	24	♂	23	32	55	16	150	26	♀	23	33	56
77	24	♂	25	32	57	16	151	26	♀	25	31	56
78	24	♂	24	32	56	16	152	26	♀	24	32	56
79	24	♂	24	33	57	16	153	26	♀	25	32	57
80	25	♂	24	33	57	16	154	26	♀	23	34	57
81	25	♂	24	33	57	16	155	26	♀	24	33	57
82	26	♂	24	32	56	16	156	26	♀	25	33	58
83	26	♂	23	33	56	16	157	26	♀	24	33	57
84	26	♂	23	33	56	16	158	26	♀	24	33	57
85	26	♂	24	32	56	16	159	26	♀	22	34	56
86	29	♂	24	32	56	16	160	26	♀	24	32	56
87	26	♂	25	32	57	17	161	26	♀	23	33	56
88	22	♀	24	33	57	..	162	26	♀	24	32	56
89	22	♀	25	32	57	..	163	26	♀	23	33	56
90	22	♀	23	33	56	..	164	27	♀	24	33	57
91	22	♀	24	33	57	..	165	27	♀	21	32	56
92	22	♀	23	35	58	..	166	27	♀	24	32	56
93	22	♀	26	31	57	..	167	27	♀	24	33	57
94	22	♀	24	34	58	..	168	27	♀	23	34	57
95	22	♀	24	33	57	..	169	27	♀	25	32	57
96	23	♀	26	31	57	..	170	27	♀	23	34	57
97	23	♀	25	31	56	..	171	27	♀	25	32	57
98	23	♀	24	33	57	..	172	27	♀	23	32	55
99	23	♀	25	32	57	..	173	27	♀	23	34	57
100	23	♀	24	33	57	..	174	27	♀	24	33	57
101	23	♀	23	33	56	..	175	27	♀	24	33	57
102	23	♀	24	33	57	..	176	27	♀	24	32	56
103	23	♀	25	31	56	..	177	27	♀	24	33	57
104	24	♀	25	31	56	..	178	27	♀	24	33	57
105	24	♀	23	33	56	..	179	28	♀	24	33	57
106	24	♀	24	33	57	..	180	28	♀	24	32	56
107	24	♀	24	32	56	..	181	30	♀	24	33	57
108	24	♀	23	32	55	..						

G. Herrings from 3 miles North of Skagen. (57° 47′N. 10° 36′ E.).

January 5. 1924. Caught in Purse Seine.

a. Young Herrings of Maturity I and II.

No.	Length cm	Sex	Maturity	Vertebrae: Pre-caudal	Vertebrae: Caudal	Vertebrae: Total	Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins: right	Rays in ventral fins: left	No. of winter-rings in scales approxim.
1	22.5	♂♂♂♂♂♂♂♂♂♂	I	24	34	58	12	15	3 + 14	8	8	3r
2	19.8	♂♂♂♂♂♂♂♂♂♂	I	23	34	57	15	16	4 + 14	9	8	3r
3	19.8	♂♂♂♂♂♂♂♂♂♂	I	24	33	57	14	16	3 + 15	9	9	3r
4	24.7	♂♂♂♂♂♂♂♂♂♂	I	24	32	56	13	16	3 + 15	9	9	3r
5	23.6	♂♂♂♂♂♂♂♂♂♂	I	24	31	55	15	15	3 + 15	9	9	3r
6	22.0	♂♂♂♂♂♂♂♂♂♂	I	23	33	56	14	14	3 + 13	9	9	4r
7	21.8	♂♂♂♂♂♂♂♂♂♂	I	24	33	57	15	16	3 + 15	9	9	3r
8	20.0	♂♂♂♂♂♂♂♂♂♂	I	24	32	56	15	15	3 + 15	9	9	4r
9	22.2	♂♂♂♂♂♂♂♂♂♂	I	23	33	56	15	15	3 + 13	9	9	3r
10	21.0	♂♂♂♂♂♂♂♂♂♂	I	24	32	56	13	16	3 + 14	9	9	3r
11	20.2	♂♂♂♂♂♂♂♂♂♂	I	23	32	55	14	14	3 + 13	9	9	3r
12	23.2	♂♂♂♂♂♂♂♂♂♂	I	24	32	56	15	14	3 + 14	9	9	3r
13	20.8	♂♂♂♂♂♂♂♂♂♂	I	24	33	57	14	16	3 + 15	9	9	3r
14	23.0	♂♂♂♂♂♂♂♂♂♂	I	26	32	58	14	15	4 + 15	9	9	4r
15	20.2	♂♂♂♂♂♂♂♂♂♂	I	23	34	57	15	16	3 + 14	9	9	3r
16	19.5	♂♂♂♂♂♂♂♂♂♂	I	25	31	56	15	16	3 + 12	9	9	3r
17	21.7	♂♂♂♂♂♂♂♂♂♂	I	24	33	57	15	15	3 + 15	9	9	3r
18	21.3	♂♂♂♂♂♂♂♂♂♂	I	23	34	57	15	16	3 + 13	9	9	3r
19	22.6	♂♂♂♂♂♂♂♂♂♂	I	24	33	57	15	15	3 + 13	9	9	4r
20	21.3	♂♂♂♂♂♂♂♂♂♂	I	25	31	56	15	15	3 + 14	9	9	4r
21	22.5	♂♂♂♂♂♂♂♂♂♂	I	23	33	56	14	16	3 + 15	9	9	3r
22	22.6	♂♂♂♂♂♂♂♂♂♂	I	23	33	56	15	16	3 + 13	9	9	3r
23	22.1	♂♂♂♂♂♂♂♂♂♂	I	25	32	57	15	17	3 + 14	8	8	3r
24	20.2	♂♂♂♂♂♂♂♂♂♂	I	24	33	57	15	16	3 + 15	9	9	2r
25	22.2	♂♂♂♂♂♂♂♂♂♂	I	22	34	56	14	16	3 + 15	9	9	3r
26	21.7	♂♂♂♂♂♂♂♂♂♂	I	24	32	56	15	15	3 + 14	9	9	3r
27	22.5	♂♂♂♂♂♂♂♂♂♂	I	23	34	57	16	16	3 + 16	9	9	3r
28	22.3	♂♂♂♂♂♂♂♂♂♂	I	25	32	57	16	16	3 + 15	9	9	3r
29	22.8	♂♂♂♂♂♂♂♂♂♂	I	24	abn.	?	16	15	3 + 13	9	9	4r
30	21.3	♂♂♂♂♂♂♂♂♂♂	I	23	33	56	15	14	3 + 14	9	9	3r
31	22.0	♂♂♂♂♂♂♂♂♂♂	I	23	34	57	15	16	3 + 15	9	8	4r
32	19.3	♂♂♂♂♂♂♂♂♂♂	I	23	32	55	14	15	3 + 14	9	9	2r
33	21.3	♂♂♂♂♂♂♂♂♂♂	I	24	33	57	14	15	2 + 14	9	9	3r
34	21.5	♂♂♂♂♂♂♂♂♂♂	I	24	32	56	15	15	4 + 13	9	9	3r
35	20.5	♂♂♂♂♂♂♂♂♂♂	I	23	34	57	14	16	3 + 13	9	8	3r
36	20.5	♂♂♂♂♂♂♂♂♂♂	I	24	32	56	14	15	3 + 14	9	9	4r
37	22.6	♂♂♂♂♂♂♂♂♂♂	I	25	31	56	14	16	3 + 15	9	9	3r
38	21.8	♂♂♂♂♂♂♂♂♂♂	I	22	34	56	14	15	3 + 15	9	9	3r
39	18.5	♂♂♂♂♂♂♂♂♂♂	I	23	33	56	15	15	4 + 15	9	8	3
40	20.5	♂♂♂♂♂♂♂♂♂♂	I	24	32	56	15	16	3 + 14	9	9	3r
41	21.2	♂♂♂♂♂♂♂♂♂♂	I	23	33	56	14	16	3 + 15	abn.	8	3r
42	19.2	♂♂♂♂♂♂♂♂♂♂	I	25	32	57	14	16	3 + 15	9	9	5r
43	19.0	♂♂♂♂♂♂♂♂♂♂	I	23	33	56	14	16	3 + 14	9	9	2r
44	20.5	♂♂♂♂♂♂♂♂♂♂	I	23	33	56	13	15	4 + 14	9	9	3r
45	19.2	♂♂♂♂♂♂♂♂♂♂	I	23	34	57	14	15	3 + 13	9	9	2r

No.	Length cm	Sex	Maturity	Vertebrae: Pre-caudal	Vertebrae: Caudal	Vertebrae: Total	Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins: right	Rays in ventral fins: left	No. of winter-rings in scales approxim.
1	23.6	♀♀♀♀♀♀♀♀♀♀	II	27	29	56	17	17	3 + 15	9	9	3r
2	24.0	♀♀♀♀♀♀♀♀♀♀	II	23	34	57	15	15	3 + 16	9	9	4r
3	24.5	♀♀♀♀♀♀♀♀♀♀	II	25	32	57	15	15	3 + 13	9	9	5r
4	24.0	♀♀♀♀♀♀♀♀♀♀	II	25	32	57	14	15	3 + 15	8	8	4r
5	25.3	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	16	15	3 + 13	9	9	4r
6	23.6	♀♀♀♀♀♀♀♀♀♀	II	24	32	56	14	15	3 + 16	9	9	3r
7	20.2	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	14	15	3 + 13	9	9	3r
8	25.6	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	15	14	3 + 15	9	9	4r
9	22.2	♀♀♀♀♀♀♀♀♀♀	II	26	31	57	15	14	3 + 15	9	9	4r
10	23.5	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	14	15	3 + 14	9	9	3r
11	23.4	♀♀♀♀♀♀♀♀♀♀	II	24	32	56	15	15	4 + 14	9	8	4r
12	24.3	♀♀♀♀♀♀♀♀♀♀	II	23	33	56	14	16	3 + 14	9	8	4r
13	22.8	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	16	15	3 + 14	9	9	3r
14	25.2	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	16	15	2 + 13	9	9	4r
15	22.3	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	16	15	3 + 15	8	8	3r
16	24.8	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	16	16	3 + 14	9	8	4r
17	24.5	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	15	16	3 + 15	9	9	4r
18	22.6	♀♀♀♀♀♀♀♀♀♀	II	23	34	57	15	16	3 + 15	9	9	3r
19	22.5	♀♀♀♀♀♀♀♀♀♀	II	23	34	57	15	16	3 + 14	9	9	3r
20	24.5	♀♀♀♀♀♀♀♀♀♀	II	23	34	57	15	16	3 + 13	8	9	4r
21	24.7	♀♀♀♀♀♀♀♀♀♀	II	23	33	56	15	15	3 + 14	9	9	4r
22	27.0	♀♀♀♀♀♀♀♀♀♀	II	23	34	57	14	16	4 + 15	9	9	5r
23	21.6	♀♀♀♀♀♀♀♀♀♀	II	25	33	58	15	14	3 + 15	8	9	3r
24	21.2	♀♀♀♀♀♀♀♀♀♀	II	23	33	56	16	16	3 + 14	9	9	4r
25	25.2	♀♀♀♀♀♀♀♀♀♀	II	23	33	56	14	16	3 + 14	8	8	4r
26	21.5	♀♀♀♀♀♀♀♀♀♀	II	25	31	56	14	15	3 + 15	9	9	3r
27	24.8	♀♀♀♀♀♀♀♀♀♀	II	22	34	56	15	14	3 + 13	9	9	5r
28	25.2	♀♀♀♀♀♀♀♀♀♀	II	24	32	56	13	16	3 + 12	9	9	4r
29	24.2	♀♀♀♀♀♀♀♀♀♀	II	25	32	57	14	16	3 + 14	9	9	3r
30	26.8	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	13	15	3 + 15	9	9	4r
31	24.8	♀♀♀♀♀♀♀♀♀♀	II	23	34	57	16	14	3 + 15	9	9	4r
32	22.8	♀♀♀♀♀♀♀♀♀♀	II	27	30	57	14	15	3 + 14	8	8	3r
33	21.7	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	14	16	3 + 12	9	9	6r
34	28.0	♀♀♀♀♀♀♀♀♀♀	II	24	32	56	15	16	3 + 15	9	9	4r
35	25.5	♀♀♀♀♀♀♀♀♀♀	II	24	32	56	14	15	3 + 16	9	9	5r
36	22.0	♀♀♀♀♀♀♀♀♀♀	II	24	32	56	15	15	3 + 15	9	9	4r
37	22.3	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	14	16	3 + 16	9	9	3r
38	26.0	♀♀♀♀♀♀♀♀♀♀	II	24	32	56	14	15	3 + 16	9	9	5r
39	23.6	♀♀♀♀♀♀♀♀♀♀	II	23	33	56	14	15	3 + 14	9	9	4r
40	24.0	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	14	15	3 + 16	8	8	4r
41	28.0	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	15	15	4 + 14	9	9	7r
42	22.2	♀♀♀♀♀♀♀♀♀♀	II	23	34	57	15	14	3 + 13	9	9	3r
43	25.0	♀♀♀♀♀♀♀♀♀♀	II	24	32	56	14	14	3 + 14	9	9	4r
44	23.0	♀♀♀♀♀♀♀♀♀♀	II	23	34	57	14	15	3 + 14	8	8	4r
45	26.0	♀♀♀♀♀♀♀♀♀♀	II	24	33	57	15	15	3 + 14	9	9	4r
46	21.8	♀♀♀♀♀♀♀♀♀♀	II	25	32	57	15	15	3 + 14	9	9	4r
47	21.3	♀♀♀♀♀♀♀♀♀♀	II	25	32	57	14	15	3 + 15	9	9	3r
48	23.7	♀♀♀♀♀♀♀♀♀♀	II	23	33	56	16	15	3 + 13	9	9	4r
49	24.8	♀♀♀♀♀♀♀♀♀♀	II	23	33	56	14	15	3 + 14	9	8	4r
50	22.7	♀♀♀♀♀♀♀♀♀♀	II	23	33	56	16	15	3 + 13	8	8	4r

b. Spring Spawners. Maturity III and IV.

No.	Length cm	Sex	Maturity	Vertebrae: Pre-caudal	Vertebrae: Caudal	Vertebrae: Total	Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins: right	Rays in ventral fins: left	No. of winter-rings in scales approxim.
1	23.0	♂♂♀♀♀♀♀♀♀♀	IV	25	33	58	14	15	3 + 15	9	9	6r
2	23.2	♂♂♀♀♀♀♀♀♀♀	IV	23	34	57	15	14	3 + 14	9	9	3r
3	26.0	♂♂♀♀♀♀♀♀♀♀	IV	25	32	57	14	16	4 + 15	9	9	3r
4	21.7	♂♂♀♀♀♀♀♀♀♀	IV	23	32	55	14	14	3 + 14	9	9	4r
5	23.5	♂♂♀♀♀♀♀♀♀♀	IV	22	35	57	14	15	4 + 15	9	9	4r
6	23.8	♂♂♀♀♀♀♀♀♀♀	IV	25	31	56	14	13	3 + 15	9	9	4r
7	24.2	♂♂♀♀♀♀♀♀♀♀	IV	22	34	56	16	16	3 + 13	9	9	5r
8	22.4	♂♂♀♀♀♀♀♀♀♀	IV	23	32	55	14	15	3 + 14	9	9	4r
9	26.0	♂♂♀♀♀♀♀♀♀♀	IV	24	33	57	15	15	3 + 15	9	9	4r
10	21.0	♂♂♀♀♀♀♀♀♀♀	IV	26	29	55	14	15	3 + 14	9	9	3r
11	25.5	♂♂♀♀♀♀♀♀♀♀	IV	23	34	57	14	15	4 + 15	9	9	4r
12	26.5	♂♂♀♀♀♀♀♀♀♀	IV	22	35	57	15	15	3 + 15	9	9	4r
13	20.8	♂♂♀♀♀♀♀♀♀♀	III	23	33	56	14	14	3 + 14	9	9	3r
14	20.4	♂♂♀♀♀♀♀♀♀♀	III	24	31	55	15	16	3 + 14	9	9	4r
15	22.5	♂♂♀♀♀♀♀♀♀♀	III	25	32	57	14	15	3 + 13	9	9	4r
16	24.5	♂♂♀♀♀♀♀♀♀♀	III	23	34	57	14	15	3 + 15	9	9	3r
17	25.0	♂♂♀♀♀♀♀♀♀♀	III	24	32	56	13	15	3 + 15	9	9	4r
18	23.1	♂♂♀♀♀♀♀♀♀♀	III	24	32	56	13	15	3 + 12	9	9	4r
19	21.8	♂♂♀♀♀♀♀♀♀♀	III	21	34	55	13	16	?	9	9	3r
20	22.6	♂♂♀♀♀♀♀♀♀♀	III	22	32	54	14	16	3 + 15	9	9	3r
21	21.7	♀♀♀♀♀♀♀♀♀♀	III	23	32	55	14	14	?	9	9	3
22	22.0	♀♀♀♀♀♀♀♀♀♀	III	24	33	57	14	14	3 + 15	9	9	3r
23	23.2	♀♀♀♀♀♀♀♀♀♀	III	24	33	57	15	15	3 + 15	9	9	4r
24	21.4	♀♀♀♀♀♀♀♀♀♀	III	22	34	56	15	15	3 + 12	9	9	3r
25	26.6	♀♀♀♀♀♀♀♀♀♀	III	23	31	54	15	15	4 + 15	9	9	4r
26	25.0	♀♀♀♀♀♀♀♀♀♀	III	22	33	55	15	15	3 + 14	9	9	4r
27	21.5	♀♀♀♀♀♀♀♀♀♀	III	22	33	55	14	15	3 + 11	9	9	4r
28	23.8	♀♀♀♀♀♀♀♀♀♀	III	22	32	54	14	15	3 + 12	9	9	4r
29	22.4	♀♀♀♀♀♀♀♀♀♀	III	23	33	56	15	15	3 + 13	9	9	3r
30	24.0	♀♀♀♀♀♀♀♀♀♀	III	24	33	57	15	15	3 + 14	9	9	4r
31	22.8	♀♀♀♀♀♀♀♀♀♀	III	24	32	56	14	14	3 + 14	9	9	4r
32	23.0	♀♀♀♀♀♀♀♀♀♀	III	25	32	57	14	16	3 + 15	9	9	4r
33	26.8	♀♀♀♀♀♀♀♀♀♀	III	24	32	56	14	15	3 + 15	9	9	4r
34	19.8	♀♀♀♀♀♀♀♀♀♀	III	24	32	56	14	15	4 + 14	9	9	3r
35	21.5	♀♀♀♀♀♀♀♀♀♀	III	24	32	56	15	15	3 + 14	9	9	4r
36	23.4	♀♀♀♀♀♀♀♀♀♀	III	23	33	56	14	15	3 + 15	9	10	4r
37	22.8	♀♀♀♀♀♀♀♀♀♀	III	23	32	55	14	15	3 + 13	9	9	3r
38	21.3	♀♀♀♀♀♀♀♀♀♀	III	23	32	55	14	15	3 + 13	9	9	4r
39	21.5	♀♀♀♀♀♀♀♀♀♀	III	24	31	55	14	14	3 + 13	9	9	4r

c. Spring Spawners and Winter Spawners of Maturity IV—VI.

No.	Length cm	Sex	Maturity	Vertebrae: Pre-caudal	Vertebrae: Caudal	Vertebrae: Total	Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins: right	Rays in ventral fins: left	No. of winter-rings in scales approxim.
1	26.2	♂♀	V	24	33	57	15	15	3 + 14	9	9	3r
2	26.8	♂♀	V	25	33	58	14	15	3 + 15	9	9	5r
3	22.4	♂♂♂♂♂♂♀♀	IV-VI	24	33	57	14	14	3 + 15	9	9	7r
4	21.0	♂♂♂♂♂♂♂♂	IV-VI	22	33	55	15	16	3 + 13	9	8	8r
5	24.0	♂♂♂♂♂♂♂♂	IV-VI	23	32	55	14	16	3 + 14	9	9	4r
6	22.6	♂♂♂♂♂♂♂♂	IV-VI	23	33	56	14	15	3 + 15	9	9	4r
7	20.5	♂♂♂♂♂♂♂♂	IV-VI	22	33	55	15	16	2 + 13	9	9	4r
8	22.5	♂♂♂♂♂♂♂♂	IV-VI	23	33	56	14	16	2 + 13	9	9	3r
9	23.7	♂♂♂♂♂♂♂♂	IV-VI	23	33	56	14	15	3 + 16	9	9	3r
10	25.5	♂♂♂♂♂♂♂♂	IV-VI	23	34	57	15	15	3 + 14	9	9	4r
11	21.5	♂♂♂♂♂♂♂♂	IV-VI	23	32	55	15	14	3 + 13	9	9	3r
12	23.0	♂♂♂♂♂♂♂♂	IV-VI	24	33	57	14	14	3 + 15	9	9	4r
13	24.0	♂♂♂♂♂♂♂♂	IV-VI	24	34	58	14	15	3 + 14	9	9	4r
14	22.7	♂♂♂♂♂♂♂♂	IV-VI	23	32	55	14	13	3 + 15	9	9	4r
15	22.2	♂♂♂♂♂♂♂♂	IV-VI	22	34	56	15	15	3 + 13	7	7	4r
16	23.8	♂♂♂♂♂♂♂♂	IV-VI	23	33	56	13	15	3 + 15	9	9	4r
17	24.5	♂♂♂♂♂♂♂♂	IV-VI	24	33	57	14	14	4 + 15	9	9	4r
18	25.0	♂♂♂♂♂♂♂♂	IV-VI	26	31	57	15	15	3 + 15	9	9	4r
19	24.7	♂♂♂♂♂♂♂♂	IV-VI	25	29	54	12	15	3 + 13	9	9	4r
20	23.0	♂♂♂♂♂♂♂♂	IV-VI	24	32	56	13	16	3 + 13	9	9	6r
21	23.5	♂♂♂♂♂♂♂♂	IV-VI	23	33	56	14	15	4 + 15	9	9	4r
22	22.7	♂♂♂♂♂♂♂♂	IV-VI	23	32	55	13	14	3 + 14	9	9	4r
23	23.2	♂♂♂♂♂♂♂♂	IV-VI	24	32	56	15	15	3 + 13	9	9	3r
24	27.0	♂♂♂♂♂♂♂♂	IV-VI	24	34	58	15	14	3 + 15	9	9	6r
25	21.2	♂♂♂♂♂♂♂♂	IV-VI	24	31	55	14	14	3 + 13	9	9	3r
26	25.5	♂♂♂♂♂♂♂♂	IV-VI	24	32	56	14	16	3 + 16	9	9	3r
27	23.5	♂♂♂♂♂♂♂♂	IV-VI	24	31	55	15	15	3 + 12	9	9	4r
28	26.8	♂♂♂♂♂♂♂♂	IV-VI	24	33	57	14	15	3 + 16	9	9	4r
29	23.6	♂♂♂♂♂♂♂♂	IV-VI	24	32	56	15	14	3 + 15	9	9	5r
30	22.5	♂♂♂♂♂♂♂♂	IV-VI	23	32	55	13	15	3 + 15	9	9	3r
31	23.3	♂♂♂♂♂♂♂♂	IV-VI	23	31	54	15	15	3 + 13	9	9	5r
32	26.7	♂♂♂♂♂♂♂♂	IV-VI	23	34	57	13	16	4 + 16	9	9	5r
33	23.0	♂♂♂♂♂♂♂♂	IV-VI	23	33	56	14	14	4 + 14	9	9	4r
34	22.1	♂♂♂♂♂♂♂♂	IV-VI	23	32	55	15	15	3 + 13	9	9	4r
35	21.7	♂♂♂♂♂♂♂♂	IV-VI	23	30	53	14	15	3 + 12	9	9	3r
36	23.0	♂♂♂♂♂♂♂♂	IV-VI	25	31	56	13	15	3 + 14	9	9	3r
37	22.3	♂♂♂♂♂♂♂♂	IV-VI	24	30	54	15	16	2 + 14	9	9	4r
38	21.6	♂♂♂♂♂♂♂♂	IV-VI	22	31	53	15	15	3 + 15	9	9	4r

d. Autumn spawners of Maturity VII—VIII.

Nr. 1—94: fat contents 0. (practically no fat).

Nr. 95—107: fat contents 1. (a little fat).

No.	Length cm	Sex	Maturity	Vertebrae: Pre-caudal	Vertebrae: Caudal	Vertebrae: Total	Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins: right	Rays in ventral fins: left	No. of winter-rings in scales approxim.
1	27.2	♂	VII-VIII	24	33	57	14	15	4 + 14	9	8	4r
2	27.5	♂♂♂♂♂♂♂♂	VII-VIII	24	33	57	16	16	3 + 16	8	8	5r
3	27.1	♂♂♂♂♂♂♂♂	VII-VIII	23	34	57	15	15	3 + 14	9	9	5r
4	27.2	♂♂♂♂♂♂♂♂	VII-VIII	23	34	57	16	16	3 + 15	9	9	5r
5	25.5	♂♂♂♂♂♂♂♂	VII-VIII	24	33	57	15	16	3 + 13	8	9	4r
6	26.0	♂♂♂♂♂♂♂♂	VII-VIII	23	33	56	15	15	3 + 13	10	10	5r
7	28.2	♂♂♂♂♂♂♂♂	VII-VIII	24	33	57	15	15	3 + 14	8	8	5r
8	26.5	♂♂♂♂♂♂♂♂	VII-VIII	23	34	57	15	15	4 + 12	9	9	4r?
9	28.1	♂♂♂♂♂♂♂♂	VII-VIII	24	33	57	14	16	4 + 15	9	9	6r
10	27.8	♂♂♂♂♂♂♂♂	VII-VIII	23	32	55	15	15	3 + 15	9	9	6r
11	25.6	♂♂♂♂♂♂♂♂	VII-VIII	24	34	58	15	15	3 + 15	8	8	5
12	26.8	♂♂♂♂♂♂♂♂	VII-VIII	26	30	56	14	16	3 + 14	8	8	7r
13	27.5	♂♂♂♂♂♂♂♂	VII-VIII	25	31	56	15	15	3 + 13	9	9	6r
14	27.7	♂♂♂♂♂♂♂♂	VII-VIII	24	33	57	16	15	3 + 16	9	8	5r
15	20.5	♂♂♂♂♂♂♂♂	VII-VIII	25	32	57	15	16	3 + 16	9	9	3r
16	24.2	♂♂♂♂♂♂♂♂	VII-VIII	23	33	56	15	15	3 + 14	9	8	4r
17	24.5	♂♂♂♂♂♂♂♂	VII-VIII	25	32	57	16	16	3 + 14	8	8	4r
18	22.5	♂♂♂♂♂♂♂♂	VII-VIII	25	31	56	16	15	2 + 14	8	8	3r
19	24.5	♂♂♂♂♂♂♂♂	VII-VIII	23	32	55	15	15	3 + 14	8	8	3r
20	24.3	♂♂♂♂♂♂♂♂	VII-VIII	25	32	57	13	16	3 + 16	9	9	3r
21	23.8	♂♂♂♂♂♂♂♂	VII-VIII	23	34	57	15	15	3 + 15	9	9	3r
22	23.0	♂♂♂♂♂♂♂♂	VII-VIII	24	33	57	16	15	3 + 16	9	9	3r
23	22.0	♂♂♂♂♂♂♂♂	VII-VIII	25	30	55	14	15	3 + 15	8	9	4r
24	28.3	♂♂♂♂♂♂♂♂	VII-VIII	25	33	58	16	15	3 + 12	8	9	6r
25	20.0	♂♂♂♂♂♂♂♂	VII-VIII	25	30	55	14	15	3 + 15	8	8	3r
26	25.0	♂♂♂♂♂♂♂♂	VII-VIII	24	32	56	14	15	2 + 14	9	9	4r
27	21.5	♂♂♂♂♂♂♂♂	VII-VIII	25	32	57	14	16	4 + 15	9	9	3r
28	29.2	♂♂♂♂♂♂♂♂	VII-VIII	24	32	56	15	15	3 + 15	9	9	6r
29	28.5	♂♂♂♂♂♂♂♂	VII-VIII	23	33	56	14	15	3 + 15	9	9	ca. 9
30	24.1	♂♂♂♂♂♂♂♂	VII-VIII	23	34	57	14	14	?	8	8	4r
31	27.2	♂♂♂♂♂♂♂♂	VII-VIII	25	32	57	16	16	3 + 14	9	9	5r
32	23.1	♂♂♂♂♂♂♂♂	VII-VIII	26	30	56	12	15	3 + 15	9	9	3r
33	25.5	♂♂♂♂♂♂♂♂	VII-VIII	24	33	57	14	16	2 + 15	9	9	5r
34	25.1	♂♂♂♂♂♂♂♂	VII-VIII	25	32	57	16	16	4 + 14	9	9	6r
35	23.5	♂♂♂♂♂♂♂♂	VII-VIII	24	33	57	15	16	3 + 15	9	9	4r
36	24.8	♂♂♂♂♂♂♂♂	VII-VIII	22	35	57	16	16	3 + 15	9	9	5r
37	23.5	♂♂♂♂♂♂♂♂	VII-VIII	25	31	56	16	16	3 + 13	9	9	5r
38	24.6	♂♂♂♂♂♂♂♂	VII-VIII	25	32	57	14	17	3 + 16	8	9	4r
39	25.1	♂♂♂♂♂♂♂♂	VII-VIII	23	34	57	17	15	3 + 13	9	9	5r
40	24.6	♂♂♂♂♂♂♂♂	VII-VIII	23	34	57	16	?	3 + 16	9	9	3r
41	23.8	♂♀♀♀♀♀♀♀	VII-VIII	23	33	56	15	14	4 + 15	9	9	4r
42	24.2	♂♀♀♀♀♀♀♀	VII-VIII	25	31	56	16	15	3 + 13	9	9	5r
43	25.5	♂♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	16	3 + 13	9	9	5r
44	29.2	♂♀♀♀♀♀♀♀	VII-VIII	24	33	57	16	15	2 + 14	9	9	6r
45	27.6	♂♀♀♀♀♀♀♀	VII-VIII	24	34	58	15	15	3 + 14	9	9	4r
46	25.3	♂♀♀♀♀♀♀♀	VII-VIII	23	32	55	15	15	?	6	8	5r
47	26.2	♂♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	16	3 + 14	9	9	5r?
48	29.2	♂♀♀♀♀♀♀♀	VII-VIII	24	33	57	14	15	3 + 14	9	9	8r
49	27.3	♂♀♀♀♀♀♀♀	VII-VIII	25	32	57	16	15	3 + 14	9	9	5r
50	26.8	♂♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	15	3 + 14	9	9	4r
51	26.0	♂♀♀♀♀♀♀♀	VII-VIII	24	33	57	15	15	3 + 13	9	9	4r
52	27.7	♂♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	17	3 + 14	9	9	4r?
53	27.8	♂♀♀♀♀♀♀♀	VII-VIII	24	33	57	14	15	3 + 15	9	9	4r
54	27.5	♂♀♀♀♀♀♀♀	VII-VIII	24	33	57	16	16	2 + 13	9	9	6r
55	28.2	♀	VII-VIII	23	33	56	15	15	3 + 14	9	9	ca. 5
56	25.1	♀♀♀♀♀♀♀♀	VII-VIII	25	31	56	15	16	3 + 16	9	9	3r
57	25.8	♀♀♀♀♀♀♀♀	VII-VIII	24	33	57	15	16	3 + 15	9	9	4r
58	23.5	♀♀♀♀♀♀♀♀	VII-VIII	23	34	57	15	16	3 + 15	9	9	4r
59	23.5	♀♀♀♀♀♀♀♀	VII-VIII	23	33	56	14	14	3 + 15	9	9	3r
60	26.0	♀♀♀♀♀♀♀♀	VII-VIII	24	35	59	15	15	4 + 14	9	9	4r
61	22.7	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	15	3 + 14	9	9	3r
62	22.7	♀♀♀♀♀♀♀♀	VII-VIII	26	31	57	16	16	3 + 14	9	9	3r
63	23.6	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	16	3 + 15	8	8	3r
64	23.6	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	15	4 + 13	8	9	4r
65	23.5	♀♀♀♀♀♀♀♀	VII-VIII	25	32	57	12	16	3 + 15	9	9	3r
66	22.8	♀♀♀♀♀♀♀♀	VII-VIII	26	30	56	14	14	3 + 15	8	8	3r
67	28.3	♀♀♀♀♀♀♀♀	VII-VIII	24	33	57	14	15	3 + 14	9	9	5r
68	27.6	♀♀♀♀♀♀♀♀	VII-VIII	24	33	57	16	14	3 + 14	9	9	6r
69	23.3	♀♀♀♀♀♀♀♀	VII-VIII	23	34	57	13	16	3 + 15	9	9	4r
70	23.0	♀♀♀♀♀♀♀♀	VII-VIII	26	30	56	14	16	3 + 15	9	9	5r
71	24.3	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	13	16	3 + 15	9	9	4r
72	23.5	♀♀♀♀♀♀♀♀	VII-VIII	24	31	55	15	15	3 + 15	9	9	3r
73	25.6	♀♀♀♀♀♀♀♀	VII-VIII	23	33	56	15	15	3 + 14	8	8	ca. 5
74	29.2	♀♀♀♀♀♀♀♀	VII-VIII	23	34	57	15	15	3 + 13	9	9	5r?
75	27.7	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	15	3 + 14	8	9	6r
76	25.5	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	16	3 + 14	9	9	4r
77	25.3	♀♀♀♀♀♀♀♀	VII-VIII	23	34	57	15	16	2 + 17	9	9	4r
78	27.3	♀♀♀♀♀♀♀♀	VII-VIII	24	33	57	14	15	3 + 13	9	9	5r?
79	29.2	♀♀♀♀♀♀♀♀	VII-VIII	23	33	56	17	15	3 + 15	9	9	5r?
80	23.8	♀♀♀♀♀♀♀♀	VII-VIII	25	32	57	15	14	3 + 13	8	8	4r
81	25.8	♀♀♀♀♀♀♀♀	VII-VIII	24	33	57	15	14	3 + 15	9	9	3r
82	24.5	♀♀♀♀♀♀♀♀	VII-VIII	24	33	57	16	16	3 + 15	9	9	3r
83	24.5	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	14	15	3 + 14	9	9	4r
84	25.5	♀♀♀♀♀♀♀♀	VII-VIII	24	33	57	15	14	3 + 12	8	7	6r
85	26.0	♀♀♀♀♀♀♀♀	VII-VIII	24	33	57	15	16	3 + 15	9	9	5r
86	25.1	♀♀♀♀♀♀♀♀	VII-VIII	23	33	56	15	15	3 + 14	9	9	5r
87	26.3	♀♀♀♀♀♀♀♀	VII-VIII	26	30	56	14	16	3 + 15	9	8	4r
88	26.8	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	15	3 + 15	9	9	4
89	27.0	♀♀♀♀♀♀♀♀	VII-VIII	23	33	56	16	16	3 + 13	8	8	4r
90	24.7	♀♀♀♀♀♀♀♀	VII-VIII	24	34	58	14	15	3 + 16	9	9	3r
91	23.0	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	15	15	3 + 15	8	8	4r
92	23.3	♀♀♀♀♀♀♀♀	VII-VIII	23	32	55	15	15	3 + 14	9	9	5r
93	22.3	♀♀♀♀♀♀♀♀	VII-VIII	24	32	56	13	abn.	3 + 16	9	9	3r
94	21.6	♀♀♀♀♀♀♀♀	VII-VIII	26	30	56	15	16	3 + 15	8	8	3r
95	27.5	♂♂♂♂♂♂♂♂	VIII	24	33	57	16	16	3 + 14	9	9	4r
96	27.5	♂♂♂♂♂♂♂♂	VIII	24	32	56	15	15	3 + 14	9	9	3r
97	28.8	♂♂♂♂♂♂♂♂	VIII	23	33	56	15	15	3 + 13	9	9	8r
98	28.8	♂♂♂♂♂♂♂♂	VIII	24	33	57	14	14	3 + 15	9	9	6r
99	28.0	♂♂♂♂♂♂♂♂	VIII	23	32	55	14	15	3 + 15	9	9	3r
100	26.3	♂♂♂♂♂♂♂♂	VIII	24	34	58	15	16	4 + 13	8	8	5r
101	27.0	♂♂♂♂♂♂♂♂	VIII	24	31	55	17	15	3 + 14	8	8	5r
102	26.6	♂♂♂♂♂♂♂♂	VIII	24	33	57	16	15	3 + 14	8	9	6r
103	25.8	♂♂♂♂♂♂♂♂	VIII	23	33	56	13	15	3 + 15	9	9	5r
104	27.6	♂♂♂♂♂♂♂♂	VIII	23	33	56	16	15	3 + 13	9	9	3r?
105	26.4	♂♂♂♂♂♂♂♂	VIII	26	31	57	15	16	3 + 17	9	9	3r
106	26.8	♂♂♂♂♂♂♂♂	VIII	25	32	57	16	15	3 + 16	9	9	7r?
107	26.2	♂♂♂♂♂♂♂♂	VIII	23	33	56	16	15	3 + 13	9	9	5r

H. Herrings from N.W. of Skagen.

January 26. 1924. Caught in Purse Seine.

a. Autumn Spawners of Maturity VII—VIII.

Fat contents 0. (practically no fat).

No.	Length cm	Vertebrae			Keeled Scales K_2	Rays in ventral fins		No. of winter-rings in scales approxim.	No.	Length cm	Vertebrae			Keeled Scales K_2	Rays in ventral fins		No. of winter-rings in scales approxim.
		Pre-caudal	Caudal	Total		right	left				Pre-caudal	Caudal	Total		right	left	
1	28.9	23	33	56	15	9	9	8 r	70	26.7	23	33	56	14	9	9	6 r
2	25.3	24	32	56	15	9	9	5 r	71	27.4	24	33	57	14	9	9	8 r
3	26.5	25	32	57	16	8	8	ca. 5 r	72	27.4	23	33	56	15	9	9	6 r
4	22.4	22	33	55	15	9	9	3 r?	73	25.4	26	31	57	15	9	9	6 r
5	26.9	24	32	56	15	9	9	8 r	74	25.3	24	32	56	15	9	9	7 r
6	27.5	23	33	56	15	9	9	7 r	75	25.1	24	34	58	16	8	8	5 r
7	26.8	25	31	56	14	9	9	8 r	76	25.7	24	31	55	16	9	9	5 r
8	28.2	23	34	57	15	9	9	6 r	77	26.8	25	33	58	15	9	9	7 r
9	28.4	22	33	55	15	8	9	8 r	78	27.9	24	33	57	15	8	9	8 r
10	27.8	24	33	57	15	9	9	6 r	79	28.3	24	32	56	15	9	9	?
11	24.9	24	33	57	15	9	9	5 r	80	21.9	25	31	56	14	9	9	3 r
12	27.2	26	31	57	16	9	9	6 r	81	26.2	23	33	56	16	9	9	5 r
13	27.4	24	34	58	16	9	9	6 r	82	25.2	23	33	56	16	9	9	6 r
14	25.7	25	32	57	13	8	9	6 r	83	28.9	23	34	57	16	9	9	8 r
15	27.3	24	33	57	15	9	9	7 r	84	26.5	24	33	57	16	9	9	4 r
16	27.8	24	33	57	15	9	9	7 r	85	25.2	23	33	56	14	9	8	5 r
17	28.3	24	32	56	15	9	9	8 r	86	25.2	25	32	57	15	9	9	6 r
18	32.2	24	32	56	15	9	9	7 r	87	23.7	23	32	55	15	9	9	4 r
19	21.0	22	33	55	14	8	8	3 r	88	23.2	..	..	..	16	abn.	8	5 r
20	27.7	25	31	56	15	9	9	4 r	89	23.2	24	32	56	16	8	8	5 r
21	25.0	24	32	56	15	8	8	5 r	90	24.1	..	..	..	15	9	9	5 r
22	25.5	..	..	..	15	9	9	5 r	91	27.2	23	33	56	13	9	9	6 r
23	27.8	23	33	56	14	7	9	7 r	92	27.1	23	33	56	15	8	9	6 r
24	23.1	..	..	..	15	9	9	3 r	93	26.9	25	32	57	14	9	9	?
25	23.5	25	32	57	14	8	8	4 r?	94	21.4	25	30	55	15	8	8	3 r
26	27.0	24	33	57	14	9	9	7 r	95	26.1	24	33	57	15	8	8	ca. 6 r
27	22.8	23	33	56	14	9	abn.	3 r	96	28.7	22	34	56	15	9	9	9 r
28	27.6	23	34	57	15	9	9	7 r	97	25.6	22	35	57	16	9	9	5 r
29	27.3	23	33	56	15	9	9	ca. 7 r	98	26.3	23	32	55	14	7	8	5 r
30	21.6	..	..	..	15	9	9	3 r	99	21.6	..	..	..	16	9	9	4 r
31	28.8	24	32	56	14	9	9	?	100	23.8	24	32	56	16	9	9	4 r
32	28.8	24	32	56	15	9	9	7 r	101	27.2	24	33	57	15	8	9	9 r
33	21.6	24	32	56	14	9	9	4 r	102	25.4	24	32	56	14	9	9	ca. 4 r
34	27.8	23	34	57	15	9	9	?	103	25.7	23	33	56	15	9	9	5 r
35	25.7	25	32	57	13	9	9	6 r	104	23.7	23	33	56	15	9	9	5 r
36	30.1	23	33	56	16	9	9	9 r	105	25.4	24	33	57	14	9	8	7 r
37	34.2	23	33	56	16	9	9	5 r	106	23.3	22	34	56	16	8	8	4 r
38	28.1	23	33	56	14	9	9	8 r	107	28.9	24	32	56	16	9	9	8 r
39	28.7	23	33	56	14	9	9	7 r	108	22.2	24	32	56	15	9	9	4 r
40	25.7	26	30	56	15	8	8	5 r	109	24.7	..	..	..	15	9	9	5 r
41	26.5	23	32	55	16	8	9	5 r	110	28.2	25	32	57	16	9	9	7 r
42	27.0	23	33	56	16	9	9	5 r?	111	27.1	24	33	57	15	9	9	ca. 6 r
43	24.5	23	34	57	14	9	9	5 r	112	29.2	24	32	56	15	9	9	10 r
44	25.4	24	33	57	15	9	8	5 r	113	23.9	24	31	55	16	8	8	5 r
45	27.0	23	33	56	15	9	9	7 r	114	21.9	25	31	56	15	8	8	4 r
46	26.9	23	33	56	15	9	9	7 r	115	25.1	23	33	56	14	9	9	ca. 5 r
47	25.1	25	32	57	14	9	9	5 r	116	25.0	24	33	57	15	9	9	?
48	23.5	..	..	..	16	9	9	4 r	117	24.7	24	32	56	15	9	9	ca. 7 r
49	25.6	24	33	57	15	8	9	6 r	118	25.5	24	33	57	15	8	8	5 r
50	28.0	24	33	57	13	9	8	6 r	119	25.5	..	..	..	16	9	9	ca. 6 r
51	26.1	24	32	56	15	9	8	5 r	120	22.2	..	..	..	15	9	10	3 r
52	26.2	24	33	57	16	9	8	4 r	121	27.7	24	32	56	15	9	9	8 r
53	23.2	25	32	57	14	9	9	4 r	122	24.0	23	33	56	16	9	9	4 r
54	25.5	24	32	56	15	8	8	6 r	123	26.2	24	33	57	13	9	9	6 r
55	28.5	23	34	57	15	8	8	8 r	124	24.1	24	33	57	15	9	8	5 r
56	24.4	24	32	56	15	9	9	5 r	125	24.7	23	33	56	15	8	8	6 r
57	23.0	..	..	..	15	9	9	3 r	126	27.2	25	32	57	15	9	9	5 r
58	24.0	..	..	..	15	9	9	4 r	127	22.8	24	33	57	16	9	8	5 r
59	29.2	24	33	57	14	9	9	7 r +	128	24.2	24	33	57	15	9	9	5 r
60	23.8	23	33	56	15	9	9	4 r	129	24.7	23	33	56	15	9	9	5 r
61	27.0	23	33	56	15	9	9	9 r	130	22.3	22	33	55	16	9	9	5 r
62	28.7	23	34	57	15	9	8	ca. 11 r	131	26.1	24	33	57	14	9	9	8 r
63	28.9	24	33	57	14	9	9	8 r	132	25.6	24	32	56	14	9	9	6 r
64	25.8	24	32	56	16	9	9	5 r	133	27.0	24	33	57	16	9	9	7 r
65	26.6	23	34	57	16	8	8	6 r	134	25.1	23	33	56	14	8	9	4-5 r
66	25.0	24	32	56	15	9	9	?	135	27.8	24	32	56	14	9	9	7 r
67	26.9	24	33	57	14	9	9	7 r	136	25.0	23	33	56	15	9	9	5 r
68	24.6	23	33	56	14	9	9	4 r	137	24.9	24	32	56	15	9	9	6 r
69	26.8	23	33	56	16	8	8	5 r	138	24.6	24	33	57	15	8	8	5 r

No.	Length cm	Vertebrae			Keeled Scales K_2	Rays in ventral fins		No. of winter-rings in scales approxim.	No.	Length cm	Vertebrae			Keeled Scales K_2	Rays in ventral fins		No. of winter-rings in scales approxim.
		Pre-caudal	Caudal	Total		right	left				Pre-caudal	Caudal	Total		right	left	
139	25.5	22	34	56	15	9	9	7 r	145	24.9	23	33	56	15	9	9	4 r
140	26.8	24	32	56	15	9	abn.	6 r	146	21.4	..	..	..	14	9	8	4 r
141	24.3	24	32	56	15	9	9	6 r	147	27.0	23	33	56	16	8	9	7 r
142	27.5	25	32	57	16	9	9	7 r	148	27.6	24	33	57	16	9	9	6 r
143	26.1	23	33	56	15	9	9	6 r	149	27.2	23	34	57	14	9	9	5 r
144	26.1	24	32	56	15	9	9	8 r	150	24.7	24	32	56	15	9	9	5 r

b. Autumn Spawners of Maturity VIII.

Fat contents 1 and + (a little fat and middling fat).

No.	Length cm	Vertebrae			Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins		No. of winter-rings in scales approxim.	No.	Length cm	Vertebrae			Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins		No. of winter-rings in scales approxim
		Pre-caudal	Caudal	Total				right	left				Pre-caudal	Caudal	Total				right	left	
1	23.7	23	34	57	16	16	3 + 12	9	9	6 r	51	25.2	23	34	57	14	16	3 + 15	8	9	5 r
2	27.2	24	33	57	15	15	?	9	9	6 r	52	25.0	23	32	55	15	15	3 + 14	8	8	5 r
3	24.9	23	33	56	15	16	3 + 15	9	9	6 r	53	25.3	24	32	56	14	15	3 + 15	9	9	4 r
4	27.5	24	33	57	14	16	3 + 14	9	9	6 r	54	25.9	25	31	56	15	16	3 + 14	9	9	5 r
5	25.4	25	30	55	15	16	3 + 14	9	9	6 r	55	24.8	23	34	57	16	14	3 + 13	9	9	4 r
6	26.5	23	33	56	14	15	3 + 14	9	9	5 r	56	26.2	23	34	57	13	15	3 + 14	9	9	6 r
7	28.6	24	32	56	14	14	3 + 14	8	8	6 r	57	27.3	23	33	56	15	16	3 + 15	9	9	6 r
8	27.1	24	33	57	16	15	3 + 13	8	9	6 r?	58	24.8	24	32	56	15	16	3 + 15	9	9	5 r
9	27.0	24	33	57	14	15	3 + 15	9	9	5 r	59	24.9	22	33	55	15	15	3 + 14	9	9	5 r
10	29.9	24	33	57	15	15	4 + 14	9	9	8 r	60	25.4	23	33	56	15	15	?	9	9	6 r?
11	29.0	25	31	56	15	15	3 + 14	9	8	6 r	61	27.1	23	33	56	14	15	3 + 11	8	7	7 r
12	25.0	23	33	56	13	15	3 + 15	9	8	6 r	62	25.6	24	32	56	15	15	3 + 13	8	8	4 r
13	24.7	23	33	56	14	15	?	9	9	6 r	63	24.9	22	34	56	15	16	3 + 15	9	9	5 r?
14	26.4	24	32	56	15	15	?	8	9	6 r	64	24.8	23	34	57	15	16	4 + 14	9	9	5 r?
15	24.7	23	34	57	16	16	3 + 15	9	9	5 r	65	26.7	24	32	56	14	16	3 + 15	8	8	6 r
16	25.4	23	34	57	15	15	?	9	9	4 r	66	25.8	24	33	57	14	16	3 + 13	8	8	5 r
17	25.2	24	33	57	15	15	3 + 13	9	9	5 r	67	27.1	23	33	56	14	?	3 + 14	9	9	6 r
18	27.3	24	33	57	13	14	3 + 13	8	8	7 r	68	24.2	22	35	57	14	16	3 + 14	9	9	4 r
19	25.4	25	31	56	15	15	3 + 14	8	8	6 r	69	24.8	24	32	56	15	16	?	8	abn.	5 r
20	24.8	24	32	56	15	15	3 + 15	9	abn.	4 r	70	27.6	23	33	56	15	16	4 + 14	9	9	7 r?
21	24.2	..	..	..	16	16	3 + 14	9	9	5 r?	71	26.5	23	34	57	15	16	?	9	9	5 r
22	25.9	25	31	56	13	16	3 + 15	9	9	6 r	72	25.5	26	30	56	14	15	3 + 15	8	9	5 r
23	25.1	25	32	57	15	15	?	9	9	4 r	73	24.8	25	31	56	13	15	3 + 15	9	9	5 r
24	24.0	25	33	58	13	15	3 + 15	9	9	4 r	74	25.1	24	33	57	15	15	3 + 14	9	9	5 r
25	24.9	23	33	56	14	16	3 + 14	9	9	5 r?	75	27.1	25	32	57	16	15	3 + 15	9	9	9 r?
26	27.7	24	32	56	16	15	3 + 15	9	9	c. 6 r	76	23.6	23	32	55	15	15	3 + 13	9	9	6 r
27	25.1	24	33	57	13	15	4 + 13	9	9	6 r	77	24.7	23	33	56	15	15	3 + 14	9	9	c. 4 r
28	27.1	23	33	56	16	14	3 + 14	9	9	7 r	78	24.4	24	32	56	14	16	3 + 15	9	9	6 r
29	29.1	22	34	56	14	15	3 + 15	9	9	7 r	79	25.2	24	34	58	16	15	3 + 14	9	9	5 r?
30	23.3	25	31	56	16	16	3 + 15	9	8	6 r	80	24.1	23	33	56	15	15	3 + 15	9	9	5 r
31	27.0	24	32	56	15	15	?	9	9	6 r	81	22.9	25	31	56	14	15	3 + 13	9	9	5 r
32	26.2	26	30	56	15	16	4 + 14	9	9	5 r	82	23.7	22	34	56	14	16	3 + 15	8	8	5 r?
33	25.2	24	33	57	16	16	3 + 15	8	8	6 r	83	24.7	24	33	57	15	14	3 + 14	8	8	4 r
34	25.2	23	33	56	15	16	3 + 14	9	9	6 r	84	25.5	24	33	57	15	15	3 + 16	8	9	5 r
35	23.9	24	32	56	15	16	3 + 14	9	9	4 r	85	23.2	23	34	57	15	16	3 + 14	9	9	5 r
36	29.0	24	33	57	15	15	3 + 15	9	9	8 r	86	25.5	23	33	56	15	14	3 + 13	9	9	6 r
37	25.5	24	33	57	14	13	3 + 13	9	9	5 r	87	25.6	24	32	56	14	15	3 + 15	9	9	4 r
38	24.2	24	33	57	15	16	3 + 15	9	9	6 r	88	25.5	23	33	56	14	15	4 + 12	9	9	5 r
39	26.4	22	34	56	17	15	4 + 14	8	8	4 r	89	27.6	25	32	57	15	14	3 + 14	9	9	6 r
40	25.0	24	33	57	14	16	4 + 13	9	9	4 r	90	27.2	24	33	57	14	16	3 + 13	9	9	7 r
41	24.8	25	32	57	15	15	3 + 15	8	8	5 r	91	26.5	23	33	56	14	15	3 + 15	9	9	6 r
42	24.7	24	32	56	13	15	3 + 14	8	8	4 r	92	26.2	23	34	57	13	14	3 + 14	9	9	6 r
43	26.3	23	34	57	16	15	3 + 16	9	9	6 r	93	25.3	23	33	56	15	15	3 + 15	9	9	6 r
44	24.2	24	32	56	14	16	3 + 14	9	8	5 r	94	27.7	23	33	56	16	14	4 + 14	9	9	6 r
45	24.7	24	33	57	14	15	4 + 15	9	9	6 r	95	27.1	24	32	56	14	15	3 + 14	9	9	6 r?
46	28.4	24	32	56	14	15	3 + 14	9	9	6 r	96	27.2	23	33	56	16	16	3 + 16	9	9	5 r?
47	25.0	24	33	57	16	16	4 + 15	9	9	5-6 r	97	24.1	24	33	57	16	15	4 + 13	9	9	4 r
48	26.9	24	33	57	14	16	4 + 13	9	9	5 r	98	24.3	23	33	56	14	16	3 + 14	8	9	5 r
49	27.9	22	34	56	15	15	3 + 15	9	9	5 r	99	29.5	23	32	55	14	16	3 + 13	9	9	8 r
50	26.0	23	34	57	13	16	3 + 14	9	9	6 r	100	25.8	23	33	56	15	16	3 + 15	9	9	6 r

J. Herrings from 12 miles W. of Cape Wrath.

March 5. 1923. — Caught in drift nets.

Ripe Spring Spawners.

No.	Length cm	Sex	Maturity	Vertebrae			Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins		No. of winter-rings in scales approxim.
				Pre-caudal	Caudal	Total				right	left	
1	31.0	♂	VI	24	33	57	15	15	3 + 14	9	9	5 r
2	29.2	♂	VI	25	32	57	14	14	3 + 15	9	9	5 r
3	32.0	♂	VI	24	33	57	14	15	4 + 15	9	9	8 r
4	30.1	♂	VI	23	34	57	14	14	3 + 13	9	9	ca. 5 r
5	28.0	♂	VI	25	32	57	14	16	3 + 15	9	9	5 r
6	30.0	♂	VI	23	34	57	15	15	4 + 14	9	9	7 r
7	30.5	♂	VI	24	33	57	14	16	3 + 15	9	9	7 r
8	30.5	♂	VI	25	31	56	14	15	4 + 14	9	9	5 r
9	31.8	♂	VI	24	34	58	16	15	4 + 16	9	9	9 r
10	31.0	♂	VI	24	33	57	14	15	3 + 15	9	9	5 r
11	30.7	♂	VI	24	34	58	14	14	3 + 13	9	9	7 r
12	28.2	♂	VI	24	32	56	13	15	4 + 15	8	9	ca. 8 r
13	29.0	♂	VI	25	31	56	14	16	3 + 13	9	9	5 r
14	30.2	♂	VI	25	31	56	13	14	3 + 15	9	9	ca. 5 r
15	28.8	♂	VI	23	34	57	12	15	4 + 15	9	9	5 r
16	30.8	♂	VI	24	34	58	14	15	3 + 15	9	9	6 r
17	28.7	♂	VI	25	32	57	14	16	3 + 15	9	9	5 r
18	30.5	♂	VI	23	34	57	14	14	3 + 17	9	9	5 r
19	30.0	♂	VI	23	34	57	14	15	3 + 14	10	9	5 r
20	29.2	♂	VI	25	33	58	14	15	3 + 16	9	9	5 r
21	29.1	♂	VI	23	33	56	14	16	3 + 15	9	9	5 r
22	29.0	♂	VI	26	33	59	14	16	3 + 15	9	9	5 r
23	30.6	♂	VI	24	32	56	13	14	3 + 15	9	9	5 r
24	29.0	♂	VI	23	34	57	15	16	3 + 14	9	9	5 r
25	29.0	♂	VI	24	33	57	14	15	3 + 14	9	9	6 r
26	27.7	♂	VI	25	33	58	14	15	3 + 15	9	9	5 r
27	30.2	♂	VI	24	32	56	14	15	3 + 15	9	9	6 r
28	29.2	♂	VI	25	31	56	13	15	3 + 14	9	9	5 r
29	29.2	♂	VI	23	33	56	13	15	3 + 15	9	9	6
30	30.0	♂	VI	24	33	57	14	15	3 + 14	9	9	6 r
31	31.8	♂	VI	25	32	57	15	15	3 + 14	9	9	8 r
32	30.2	♂	VI	24	34	58	14	15	3 + 16	9	9	5 r
33	30.5	♂	VI	24	34	58	15	15	3 + 16	9	9	5 r
34	29.2	♂	VI	24	33	57	15	16	4 + 15	9	9	5 r
35	30.1	♂	VI	26	31	57	15	15	3 + 14	10	9	6 r
36	30.0	♂	VI	24	34	58	16	15	4 + 15	9	9	5 r
37	29.8	♂	VI	25	32	57	15	16	3 + 15	9	8	5 r
38	28.0	♂	VI	25	32	57	13	16	3 + 15	9	8	5 r
39	26.5	♂	VI	26	31	57	16	16	3 + 16	9	9	6 r
40	30.5	♂	VI	24	33	57	14	15	3 + 16	9	9	5 r
41	27.8	♂	VI	24	33	57	13	15	3 + 15	9	9	5
42	29.5	♂	VI	25	33	58	14	15	3 + 15	9	9	5 r
43	30.2	♂	VI	24	33	57	15	14	4 + 13	9	9	6 r
44	30.0	♂	VI	23	34	57	13	15	4 + 15	9	6	ca. 7 r
45	29.7	♂	VI	25	32	57	15	16	3 + 16	9	9	5 r
46	29.3	♂	VI	24	34	58	14	14	3 + 14	9	9	6 r
47	30.0	♂	VI-VII	25	32	57	13	16	3 + 15	10	9	5 r
48	29.5	♂	VI	24	33	57	15	15	3 + 15	9	9	5 r
49	30.0	♂	VI	24	32	56	14	16	4 + 15	9	9	5 r
50	29.7	♂	VI-VII	24	33	57	14	15	4 + 15	9	9	5 r
51	32.5	♂	VI	24	34	58	14	15	3 + 14	9	9	7 r
52	30.0	♂	VI	23	35	58	15	15	3 + 15	9	9	5 r
53	30.5	♂	VI	25	33	58	14	14	3 + 16	9	9	?
54	30.0	♂	VI	24	33	57	15	16	3 + 15	9	9	5 r
55	29.3	♂	VI	23	34	57	13	15	3 + 16	9	9	6 r
56	29.5	♂	VI	26	31	57	14	16	3 + 15	9	9	6 r
57	29.2	♂	VI	24	33	57	14	15	3 + 13	9	9	5 r
58	29.5	♂	VI	23	34	57	15	15	3 + 16	9	9	6 r
59	29.8	?	VI	26	31	57	13	16	3 + 16	9	9	5 r
60	30.3	♂	VI	23	33	56	13	16	3 + 16	9	9	5 r
61	30.2	♂	VI	24	34	58	14	16	3 + 16	9	9	5 r
62	32.2	♂	VI	24	33	57	15	15	3 + 14	9	9	ca. 8 r
63	30.3	♂	VI	23	34	57	15	16	3 + 15	9	9	5 r
64	30.5	♂	VI	23	34	57	15	15	3 + 15	9	9	5 r
65	29.7	♂	VI	23	34	57	14	15	3 + 15	9	9	5 r
66	29.0	♂	VI	24	32	56	13	15	3 + 15	9	9	5 r
67	31.0	♂	VI	25	32	57	14	15	3 + 15	9	9	ca. 6 r
68	30.2	♂	VI	25	32	57	13	15	3 + 15	9	9	5 r
69	28.0	♂	VI	24	33	57	14	15	4 + 13	8	9	7 r
70	30.5	♂	VI	24	33	57	13	15	3 + 16	9	9	6 r
71	29.0	♂	VI	25	31	56	13	16	3 + 16	9	9	5 r
72	29.8	♂	VI	25	32	57	14	16	3 + 17	9	9	5 r
73	30.5	♂	VI	23	34	57	16	16	3 + 16	9	9	5 r
74	29.3	♂	VI	23	33	56	14	16	3 + 15	9	9	5 r
75	31.2	♂	VI	24	33	57	14	15	4 + 15	9	9	5 r
76	32.8	♂	VI	25	32	57	12	15	3 + 15	9	9	7 r
77	29.5	♂	VI	24	33	57	14	15	3 + 15	9	9	ca. 6 r
78	28.0	♂	VI	24	33	57	13	15	3 + 15	9	9	6 r
79	30.0	♂	VI	25	32	57	15	16	3 + 14	9	9	5 r
80	30.5	♂	VI	23	33	56	14	15	3 + 16	9	9	6 r
81	28.8	♂	VI	25	32	57	13	15	3 + 15	9	9	5 r
82	30.0	♂	VI	23	34	57	14	16	4 + 15	9	9	5 r
83	28.8	♂	VI	25	33	58	14	15	3 + 15	9	9	7 r
84	30.4	♂	VI	25	32	57	14	15	2 + 15	9	9	5 r
85	29.3	♂	VI	24	33	57	14	16	4 + 14	9	9	5 r
86	30.3	♂	VI	24	34	58	14	15	3 + 15	9	9	5 r
87	29.2	♂	VI	27	32	59	15	15	3 + 14	8	9	5 r
88	30.2	♂	VI	25	32	57	13	16	4 + 14	9	9	7 r
89	29.3	♂	VI	24	33	57	13	15	2 + 16	9	9	5 r
90	26.8	♂	VI	24	32	56	13	15	4 + 14	9	9	4 r
91	29.5	♂	VI	23	33	56	15	15	3 + 16	9	10	5 r
92	30.0	♂	VI	25	32	57	13	15	3 + 15	9	9	5 r
93	30.2	♂	VI	25	32	57	13	16	3 + 16	9	9	5 r
94	28.0	♂	VI	25	32	57	13	16	3 + 16	9	9	5 r
95	29.0	♂	VI	24	34	58	13	?	3 + 16	9	9	6 r
96	30.0	♂	VI	24	33	57	13	16	3 + 16	9	9	6 r
97	29.3	♂	VI	23	34	57	13	15	3 + 16	9	9	5 r
98	29.0	♂	VI	26	31	57	14	16	3 + 15	9	9	5 r
99	29.2	♂	VI	23	33	56	14	16	3 + 15	9	9	5 r
100	30.0	♂	VI	25	32	57	14	16	4 + 15	9	9	5 r
101	29.3	♂	VI	25	32	57	13	16	3 + 15	10	10	5 r
102	30.7	♂	VI	24	32	56	14	14	3 + 16	9	9	5 r
103	30.0	♂	VI	25	33	58	13	15	3 + 14	9	9	5 r
104	29.5	♂	VI	24	33	57	14	15	3 + 15	9	9	5 r
105	29.4	♂	VI	24	33	57	15	16	4 + 14	9	9	6 r
106	28.8	♂	VI	24	33	57	14	15	3 + 16	9	9	5 r
107	30.6	♂	VI	24	34	58	14	14	3 + 14	9	9	6 r
108	29.8	♂	VI	25	33	58	14	15	3 + 15	9	9	ca. 5 r
109	27.8	♂	VI	24	33	57	15	15	3 + 15	9	9	7 r
110	29.6	♂	VI	24	33	57	14	16	3 + 16	9	9	5 r
111	29.6	♂	VI	23	34	57	14	15	3 + 15	9	9	5 r
112	29.5	♂	VI	24	33	57	14	15	3 + 16	9	9	5 r
113	30.0	♂	VI	24	34	58	14	16	4 + 15	9	9	5 r
114	29.5	♂	VI	24	33	57	13	15	3 + 15	9	9	5 r
115	28.7	♂	VI	23	34	57	14	16	3 + 15	9	9	5 r
116	32.1	♂	VI	23	34	57	13	15	4 + 14	9	9	8 r
117	28.1	♂	VI	24	32	56	14	15	3 + 15	9	9	4 r
118	30.2	♂	VI	24	33	57	14	15	3 + 14	9	9	5 r
119	30.2	♂	VI	24	33	57	14	16	3 + 15	9	9	5 r
120	30.6	♂	VI	24	32	56	14	15	3 + 15	9	9	5 r
121	30.2	♂	VI	24	33	57	14	15	3 + 15	9	9	5 r
122	30.0	♂	VI	24	35	59	14	16	3 + 15	9	9	5 r
123	30.0	♂	VI	25	32	57	13	15	3 + 15	9	9	6 r
124	32.7	♂	VI	25	33	58	15	15	3 + 15	9	?	6 r
125	29.3	♂	VI	23	34	57	14	16	3 + 16	9	9	6 r
126	28.5	♂	VI	24	33	57	14	16	3 + 15	9	9	5 r
127	28.5	♂	VI	25	33	58	14	14	3 + 16	9	8	6 r
128	29.2	♂	VI	26	31	57	14	16	3 + 15	9	9	5 r
129	29.7	♂	VI	24	33	57	14	15	3 + 14	10	10	5 r
130	29.6	♂	VI	24	34	58	14	16	3 + 15	9	9	5 r
131	29.7	♂	VI	24	32	56	13	15	3 + 16	9	9	5 r
132	29.7	♂	VI	24	33	57	13	16	3 + 17	9	9	5 r
133	28.3	♂	VI	25	33	58	15	17	3 + 15	9	9	4 r
134	28.5	♂	VI	24	33	57	13	15	3 + 15	9	9	5 r
135	29.5	♂	VI	24	33	57	13	14	3 + 14	9	9	5 r
136	30.4	♂	VI	24	34	58	14	16	3 + 15	9	9	5 r
137	29.0	♂	VI	24	32	56	14	15	4 + 14	9	9	5 r
138	31.2	♂	VI	23	34	57	14	?	3 + 16	9	9	5 r
139	29.6	♂	VI	23	34	57	14	15	3 + 14	9	9	5 r
140	29.3	♂	VI	23	34	57	15	16	3 + 16	9	9	5 r
141	29.5	♂	VI	25	32	57	15	15	3 + 15	9	9	5 r
142	29.8	♂	VI	25	31	56	13	15	3 + 13	9	9	5 r

No.	Length cm	Sex	Maturity	Vertebrae			Keeled scales Kg	Rays in dorsal fin	Rays in anal fin	Rays in ventral fins		No. of winter-rings in scales approxim.
				Pre-caudal	Caudal	Total				right	left	
143	29.7	♂	VI	25	32	57	13	15	4 + 15	9	9	5 r
144	30.5	♂	VI	26	32	58	14	15	3 + 15	9	9	5 r
145	29.4	♂	VI	24	33	57	14	15	3 + 15	9	9	5 r
146	29.5	♂	VI	23	33	56	14	15	3 + 16	10	9	5 r
147	30.5	♂	VI	24	32	56	14	16	3 + 15	9	9	5 r
148	29.8	♂	VI	25	33	58	14	15	3 + 16	9	9	5 r
149	30.1	♂	VI	24	33	57	14	15	3 + 15	9	9	ca. 5 r
150	29.7	♂	VI	24	33	57	14	15	3 + 15	?	9	5 r
151	28.6	♂	VI	26	32	58	15	15	3 + 14	9	9	5 r
152	31.5	♂	VI	24	33	57	14	15	3 + 16	9	9	6 r
153	30.2	♂	VI	24	33	57	14	16	3 + 13	9	9	5 r
154	30.4	♂	VI	26	32	58	14	15	3 + 15	9	9	5 r
155	28.7	♂	VI	23	34	57	15	16	3 + 14	9	9	5 r
156	28.4	♂	VI	24	33	57	14	15	3 + 16	9	9	5 r
157	29.2	♂	VI	24	33	57	13	15	3 + 14	9	9	5 r
158	30.0	♂	V-VI	24	33	57	13	15	4 + 16	9	9	5 r
159	29.8	♂	VI	24	34	58	14	15	3 + 14	9	9	6 r
160	29.7	♂	VI	23	34	57	14	14	3 + 15	9	9	5 r
161	28.7	♂	VI	24	34	58	13	16	3 + 15	9	9	5 r
162	29.2	♂	VI	25	32	57	13	15	3 + 15	9	9	5 r
163	29.0	♂	VI	24	33	57	14	15	3 + 15	9	9	5 r
164	28.5	♂	VI	24	33	57	14	15	3 + 15	9	9	5 r
165	29.2	♂	VI	24	33	57	14	15	3 + 15	9	9	?
166	28.9	♂	VI	23	34	57	14	15	3 + 15	9	9	5 r
167	29.3	♂	VI	24	33	57	15	15	3 + 14	9	9	5 r
168	30.9	♂	VI	24	34	58	15	15	3 + 16	9	9	5 r
169	27.6	♂	VI	24	33	57	13	15	3 + 15	9	9	5 r
170	27.6	♂	VI	23	34	57	15	16	3 + 15	9	9	6 r
171	29.7	♂	VI	24	34	58	15	14	3 + 15	9	9	5 r
172	28.7	♂	VI	25	32	57	14	15	4 + 15	9	9	5 r
173	29.2	♂	VI	23	34	57	15	15	4 + 15	9	9	6 r
174	29.4	♂	VI	23	34	57	14	15	4 + 15	9	9	ca. 5 r
175	29.5	♂	VI	24	34	58	15	15	3 + 15	9	9	6 r
176	29.0	♂	VI	24	33	57	14	16	2 + 14	9	9	5 r
177	29.8	♂	VI	24	34	58	13	14	4 + 15	9	9	5 r
178	29.8	♂	VI	24	33	57	14	14	3 + 15	9	9	5 r
179	28.8	♂	VI	24	33	57	15	15	3 + 15	9	10	5 r
180	29.5	♂	VI	24	33	57	14	16	3 + 15	9	9	5 r
181	33.0	♂	VI	23	35	58	15	4 + 15	3 + 15	9	9	ca. 7 r
182	28.5	♂	VI	24	32	56	13	4 + 16	3 + 15	9	9	5 r
183	30.5	♂	VI	23	34	57	14	4 + 17	4 + 15	9	9	6 r
184	30.0	♂	VI	24	33	57	13	4 + 15	3 + 15	9	9	5 r
185	28.6	♂	VI	23	34	57	14	4 + 14	3 + 14	9	9	ca. 5 r
186	33.5	♂	VI	24	34	58	14	3 + 15	3 + 15	9	9	8 r
187	29.3	♂	VI	24	33	57	13	4 + 16	3 + 15	9	9	5 r
188	29.5	♂	VI	25	33	58	14	4 + 15	4 + 14	9	9	5 r
189	29.2	♂	VI	25	32	57	14	5 + 15	4 + 14	9	9	5 r
190	30.8	♂	VI	23	34	57	15	5 + 15	4 + 15	9	9	7 r
191	30.3	♂	VI	24	33	57	14	5 + 14	3 + 15	9	9	ca. 8 r
192	28.8	♂	VI	26	32	58	14	5 + 15	3 + 14	9	9	?
193	28.6	♂	VI	24	33	57	15	4 + 16	3 + 15	9	9	5 r
194	30.5	♂	VI	24	33	57	12	4 + 16	3 + 15	9	9	5 r
195	29.4	♂	VI	24	33	57	14	4 + 15	3 + 16	9	9	5 r
196	28.8	♂	VI	25	32	57	14	4 + 15	3 + 15	9	9	7 r
197	29.6	♂	VI	25	32	57	13	4 + 15	3 + 15	9	9	5 r
198	28.5	♂	VI	25	34	59	14	5 + 15	3 + 14	9	9	5 r
199	33.0	♂	VI	26	32	58	13	4 + 14	3 + 14	9	9	7 r
200	29.4	♂	VI	24	33	57	14	4 + 16	4 + 16	9	9	5 r
201	28.8	♂	VI	25	32	57	14	4 + 15	3 + 14	9	9	5 r
202	30.0	♂	VI	23	34	57	15	5 + 14	3 + 15	9	9	ca. 7 r
203	28.8	♂	VI	24	33	57	14	4 + 15	3 + 13	9	8	5 r
204	29.7	♂	VI	24	33	57	13	4 + 16	3 + 16	9	9	5 r
205	29.8	♂	VI	24	32	56	13	4 + 15	3 + 16	9	9	5 r
206	29.3	♂	VI	23	35	58	15	4 + 15	3 + 14	9	10	5 r
207	29.2	♂	VI	24	33	57	14	3 + 16	2 + 16	9	9	5 r
208	30.8	♂	VI	24	33	57	13	4 + 15	3 + 15	9	9	5 r
209	30.2	♂	VI	25	32	57	14	3 + 16	3 + 14	8	9	6 r
210	27.9	♂	VI	24	33	57	14	4 + 15	4 + 14	9	9	ca. 5 r
211	28.5	♂	VI	24	33	57	14	4 + 16	3 + 15	9	9	4 r
212	30.5	♂	VI	25	33	58	14	5 + 14	3 + 15	9	9	5 r
213	30.5	♂	VI	23	34	57	13	4 + 15	3 + 14	9	9	ca. 5 r
214	29.6	♂	VI	24	33	57	15	4 + 14	4 + 15	9	9	5 r
215	29.7	♂	VI	25	33	58	15	4 + 15	4 + 15	9	9	5 r
216	29.3	♂	VI	25	32	57	13	4 + 15	3 + 14	9	9	5 r
217	30.0	♂	VI	24	33	57	13	4 + 15	3 + 16	9	9	5 r
218	30.5	♂	VI	25	33	58	13	4 + 15	3 + 15	9	9	5 r
219	30.8	♂	VI	23	34	57	14	4 + 16	3 + 16	9	9	5 r
220	30.2	♂	VI	24	33	57	13	4 + 16	3 + 16	9	9	5 r
221	29.2	♂	VI	24	33	57	14	4 + 15	3 + 15	9	9	5 r
222	30.2	♂	VI	25	32	57	13	4 + 16	4 + 15	8	9	5 r
223	29.0	♂	VI	23	34	57	14	4 + 15	3 + 16	9	9	6 r
224	30.5	♂	VI	25	33	58	14	4 + 16	3 + 15	9	9	5 r
225	32.0	♂	VI	25	31	56	14	5 + 15	4 + 15	9	9	?
226	29.4	♂	VI	25	32	57	14	4 + 15	3 + 16	9	10	6 r
227	30.2	♂	VI	25	32	57	14	4 + 16	3 + 16	9	9	5 r
228	28.6	♂	VI	23	34	57	15	4 + 15	3 + 14	9	9	4 r
229	30.8	♂	VI	25	33	58	15	4 + 15	3 + 14	9	9	5 r
230	30.0	♂	VI	24	33	57	13	?	3 + 14	9	9	5 r
231	30.2	♂	VII	24	33	57	14	5 + 15	3 + 15	9	9	5 r
232	31.5	♂	VI	24	33	57	14	4 + 14	3 + 13	9	9	7 r
233	28.8	♂	VI	24	32	56	12	5 + 14	3 + 15	9	9	5 r
234	29.6	♂	VI	24	33	57	14	4 + 15	3 + 16	9	9	5 r
235	32.4	♂	VI	24	34	58	14	4 + 15	3 + 15	9	9	6 r
236	29.5	♂	VI	24	34	58	14	5 + 15	4 + 16	9	9	5 r
237	30.0	♂	VI	24	33	57	14	4 + 15	3 + 16	9	9	5 r
238	29.7	♂	VI	24	33	57	14	4 + 16	3 + 15	9	9	5 r
239	29.3	♂	VI	24	33	57	14	5 + 14	3 + 15	9	9	5 r
240	30.0	♂	VI	25	33	58	13	4 + 14	3 + 15	9	9	5 r
241	30.4	♂	VI	25	33	58	14	4 + 16	3 + 15	9	9	5 r
242	28.0	♂	VI	23	34	57	14	4 + 15	4 + 15	9	9	ca. 5 r
243	30.2	♂	VI	26	31	57	14	5 + 16	3 + 17	9	9	5 r
244	29.6	♂	VI	23	34	57	13	4 + 16	4 + 14	9	9	5 r
245	28.2	♂	VI	24	33	57	13	4 + 15	3 + 14	9	9	5 r
246	30.6	♂	VI	24	33	57	14	5 + 15	3 + 14	9	9	5 r
247	31.8	♂	VI	24	33	57	14	4 + 16	3 + 14	9	9	ca. 6 r
248	28.2	♂	VI	25	33	58	14	5 + 15	3 + 16	9	9	5 r
249	31.3	♂	VI	25	33	58	13	5 + 16	4 + 17	9	9	5 r
250	29.5	♂	VI	24	34	58	13	4 + 16	3 + 15	9	9	5 r
251	30.3	♂	VI	24	33	57	13	4 + 15	3 + 14	9	9	5 r
252	30.2	♂	VI	26	32	58	14	5 + 15	3 + 15	9	9	5 r
253	29.5	♂	VI	23	33	56	15	4 + 16	3 + 15	9	9	7 r
254	29.4	♂	VI	23	33	56	13	4 + 15	4 + 15	9	9	5 r
255	30.4	♂	VI	25	32	57	14	4 + 14	3 + 14	9	9	5 r
256	30.5	♂	VI	23	35	58	13	4 + 13	3 + 15	9	9	5 r
257	29.0	♂	VI	24	33	57	14	4 + 15	3 + 15	9	9	5 r
258	30.6	♂	VI	23	34	57	14	4 + 16	3 + 15	9	9	5 r
259	28.4	♂	VI	24	33	57	14	4 + 16	3 + 15	9	10	5 r
260	29.3	♂	VI	25	32	57	13	4 + 16	3 + 15	9	9	5 r
261	30.4	♂	VI	25	33	58	15	4 + 16	3 + 16	9	9	7 r
262	29.2	♂	VI	23	34	57	13	4 + 14	3 + 14	9	9	6 r
263	30.6	♂	VI	25	33	58	15	4 + 15	3 + 15	9	9	7 r
264	30.2	♂	VI	24	33	57	14	4 + 15	3 + 15	9	9	5 r
265	31.2	♂	VI	23	34	57	13	5 + 16	3 + 15	9	9	5 r
266	29.5	♂	VI	24	33	57	14	4 + 15	3 + 16	9	9	5 r
267	31.2	♂	VI	25	33	58	13	4 + 15	3 + 13	9	9	5 r
268	28.7	♂	VI	24	33	57	14	4 + 15	3 + 14	9	9	5 r
269	28.2	♂	VI	25	33	58	15	4 + 16	3 + 16	9	9	5 r
270	31.5	♂	VI	25	32	57	14	4 + 16	3 + 13	9	9	ca. 6 r

K. Herrings from 9 miles N. of Flugga. (Shetland Isles).

March 21. 1923. Caught in drift nets.

Spring Spawners of Maturity VII.

No.	Length cm	Sex	Vertebrae			Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins		No. of winter-rings in scales approxim.
			Pre-caudal	Caudal	Total				right	left	
1	29.0	♂	25	32	57	15	14	3 + 15	9	9	5 r
2	30.5	♂♀	24	32	56	13	15	3 + 15	9	9	5 r
3	29.5	♂♀	24	33	57	15	16	3 + 15	9	9	5 r
4	29.8	♂♀	24	33	57	13	17	3 + 14	9	9	5 r
5	29.8	♂♀	25	32	57	13	15	3 + 16	9	9	5 r
6	29.6	♂♀	24	33	57	14	15	3 + 14	9	9	4 r
7	29.5	♂♀	24	34	58	15	16	3 + 15	9	9	6 r
8	27.8	♂♀	24	32	56	13	15	3 + 15	9	9	5 r
9	30.4	♂♀	23	32	55	14	16	3 + 16	9	9	6 r
10	29.5	♂♀	24	33	57	14	16	3 + 15	9	9	5 r
11	28.0	♂♀	24	32	56	14	15	3 + 16	9	9	5 r
12	30.3	♂♀	23	34	57	13	16	3 + 15	9	9	ca. 5 r
13	29.2	♂♀	24	33	57	15	15	3 + 15	9	9	8 r
14	29.5	♂♀	26	32	58	14	16	4 + 15	9	9	6 r
15	29.5	♂♀	25	32	57	14	14	3 + 15	9	9	5 r
16	29.0	♂♀	24	32	56	14	15	3 + 15	9	9	5 r
17	29.7	♂♀	24	33	57	13	15	3 + 15	9	9	5 r
18	28.2	♂♀	24	33	57	14	15	3 + 14	9	9	5 r
19	30.2	♂♀	25	32	57	14	16	3 + 16	9	9	5 r
20	29.0	♂♀	24	34	58	14	15	3 + 16	9	9	5 r
21	29.4	♂♀	26	31	57	14	15	3 + 14	9	9	5 r
22	29.7	♂♀	26	31	57	14	16	3 + 14	9	9	5 r
23	28.5	♂♀	25	33	58	14	16	3 + 14	9	9	5 r
24	29.5	♂♀	24	33	57	13	15	3 + 15	9	9	5 r
25	29.0	♂♀	24	33	57	13	16	4 + 15	9	9	5 r
26	30.0	♂♀	24	33	57	14	15	4 + 14	9	9	5 r
27	28.7	♂♀	22	33	55	14	15	3 + 14	9	9	5 r
28	28.8	♂♀	25	32	57	14	15	3 + 15	9	9	5 r
29	30.0	♂♀	25	32	57	14	14	3 + 15	9	9	5 r
30	30.3	♂♀	25	33	58	14	15	3 + 15	9	9	5 r
31	28.5	♂♀	23	34	57	13	15	4 + 14	9	9	ca. 5 r
32	30.8	♂♀	25	31	56	14	15	3 + 15	9	9	5 r
33	29.0	♂♀	23	33	56	13	15	3 + 16	9	9	6 r
34	29.5	♂♀	23	34	57	14	15	3 + 14	9	9	6 r
35	30.6	♂♀	24	33	57	12	14	3 + 16	9	9	5 r
36	30.2	♂♀	24	33	57	15	15	4 + 15	9	9	5 r
37	29.5	♂♀	24	33	57	13	15	4 + 16	9	9	5 r
38	29.5	♂♀	26	31	57	14	15	3 + 14	9	9	5 r
39	30.4	♂♀	24	33	57	14	15	4 + 15	9	9	6 r
40	25.5	♂♀	26	31	57	14	16	3 + 16	9	9	4 r
41	33.0	♂♀	25	31	56	14	16	3 + 15	9	9	8 r
42	26.4	♂♀	23	34	57	14	15	4 + 14	9	9	ca. 6 r
43	29.2	♂♀	24	33	57	14	15	3 + 15	9	9	5 r
44	29.6	♂♀	23	33	56	14	16	3 + 15	9	9	5 r
45	29.3	♂♀	24	33	57	13	16	3 + 16	9	9	4 r
46	25.6	♂♀	25	32	57	14	16	3 + 15	9	9	5 r
47	27.7	♂♀	23	35	58	14	15	3 + 14	9	9	5 r
48	25.3	♂♀	23	34	57	13	15	3 + 15	9	9	5 r
49	29.8	♂♀	24	32	56	13	15	3 + 15	9	9	5 r
50	29.0	♂♀	25	32	57	16	14	4 + 14	9	9	ca. 6 r
51	28.5	♂♀	24	33	57	14	16	3 + 15	9	9	5 r
52	30.2	♂♀	24	34	58	13	15	4 + 15	9	9	6 r
53	29.8	♂♀	26	31	57	14	16	3 + 16	9	9	5 r
54	29.4	♂♀	25	32	57	13	15	3 + 15	9	9	5 r
55	28.7	♂♀	25	32	57	14	?	3 + 15	9	9	5 r
56	30.0	♂♀	24	34	58	13	15	3 + 14	9	9	5 r
57	29.5	♂♀	23	33	56	13	15	3 + 15	9	9	5 r
58	30.0	♂♀	26	31	57	13	15	3 + 16	9	9	7 r
59	28.5	♂♀	25	32	57	15	16	4 + 15	9	9	5 r
60	30.5	♂♀	25	32	57	13	15	3 + 16	9	9	5 r
61	29.0	♂♀	25	33	58	13	15	4 + 14	9	9	8 r
62	30.8	♂♀	25	33	58	14	14	3 + 16	9	9	5 r
63	28.6	♂♀	25	33	58	14	14	3 + 16	9	9	5 r
64	30.2	♂♀	26	32	58	13	16	3 + 16	9	9	5 r
65	29.3	♂♀	25	32	57	13	16	3 + 15	9	9	5 r
66	29.5	♂♀	23	34	57	15	16	3 + 14	9	9	5 r
67	29.3	♂♀	25	32	57	13	15	3 + 16	9	9	5 r
68	30.0	♂♀	25	32	57	14	15	3 + 15	9	9	5 r
69	30.8	♂♀	26	32	58	13	15	3 + 14	9	9	ca. 3 r
70	29.5	♂♀	25	33	58	13	14	3 + 15	9	9	5 r
71	29.7	♂♀	23	34	57	13	16	3 + 15	9	9	5 r
72	30.5	♂♀	24	33	57	13	15	3 + 16	9	9	5 r
73	30.1	♂♀	25	32	57	13	15	4 + 15	9	9	5 r
74	30.0	♂	24	34	58	13	15	3 + 15	9	10	5 r
75	30.5	♂♀	25	32	57	13	15	3 + 14	9	9	5 r
76	28.5	♂♀	24	33	57	15	16	4 + 15	9	10	5 r
77	29.2	♂♀	25	32	57	15	15	3 + 15	9	9	5 r
78	29.8	♂♀	25	32	57	14	16	3 + 15	9	9	5 r
79	30.2	♂♀	25	32	57	14	16	3 + 15	9	9	6 r
80	30.8	♂♀	25	32	57	14	15	4 + 15	9	9	5 r
81	27.0	♂♀	24	32	56	13	15	4 + 15	9	9	5 r
82	28.5	♂♀	24	33	57	13	16	3 + 15	9	9	5 r
83	28.5	♂♀	27	30	57	15	14	4 + 13	9	9	5 r
84	29.4	♂♀	24	33	57	14	16	3 + 15	9	9	5 r
85	31.4	♂♀	26	32	58	15	14	4 + 14	9	9	6 r
86	27.8	♂♀	24	32	56	15	16	3 + 14	9	9	5 r
87	33.8	♂♀	25	33	58	14	15	3 + 15	9	9	7 r
88	29.2	♂♀	24	33	57	13	15	3 + 15	9	9	ca. 7 r
89	29.7	♂♀	25	32	57	13	14	3 + 15	9	9	?
90	29.7	♂♀	25	31	56	14	16	3 + 15	9	9	5 r
91	30.6	♂♀	25	32	57	14	16	3 + 15	9	9	6 r
92	29.5	♂♀	25	34	59	14	15	4 + 15	8	9	6 r
93	30.3	♂♀	25	32	57	13	15	3 + 16	9	9	5 r
94	29.3	♂♀	24	33	57	14	15	3 + 17	9	9	5 r
95	29.6	♂♀	24	33	57	14	15	3 + 15	9	9	5 r
96	29.2	♂♀	24	33	57	14	14	3 + 15	8	9	6 r
97	27.5	♂♀	26	31	57	13	15	3 + 15	9	9	4 r
98	28.5	♂♀	25	32	57	13	16	3 + 16	9	9	6 r
99	29.8	♂♀	25	32	57	14	14	4 + 15	9	9	5 r
100	29.5	♂♀	25	32	57	14	15	3 + 14	9	9	6 r
101	32.5	♂♀	26	31	57	14	16	3 + 15	9	10	ca. 6 r
102	29.7	♂♀	24	33	57	14	15	3 + 16	9	9	5 r
103	29.5	♂♀	24	34	58	13	16	3 + 15	9	9	5 r
104	28.5	♂♀	26	30	56	14	16	3 + 16	10	10	5 r
105	29.5	♂♀	25	33	58	14	16	3 + 16	9	9	5 r
106	28.8	♂♀	24	32	56	13	15	3 + 16	10	9	5 r
107	30.0	♂♀	26	32	58	15	17	3 + 16	9	9	6 r
108	29.0	♂♀	24	33	57	14	15	3 + 15	9	9	5 r
109	31.3	♂♀	24	33	57	12	15	4 + 15	9	9	5 r
110	28.5	♂♀	25	32	57	14	15	3 + 15	9	9	5 r
111	30.0	♂♀	25	32	57	14	15	3 + 15	9	8	6 r
112	30.2	♂♀	24	33	57	12	16	3 + 16	9	9	5 r
113	28.5	♂♀	26	31	57	14	15	3 + 15	9	9	5 r
114	31.0	♂♀	24	33	57	14	15	4 + 15	9	9	6 r
115	29.7	♂♀	24	33	57	14	15	4 + 14	9	9	4 r
116	32.5	♂♀	25	32	57	13	16	3 + 15	10	10	ca. 8 r
117	31.0	♂♀	25	33	58	14	15	4 + 15	9	9	5 r
118	29.7	♂♀	24	33	57	14	16	3 + 15	9	8	5 r
119	30.2	♂♀	25	33	58	13	15	3 + 16	9	9	6 r
120	30.5	♂♀	24	33	57	14	16	3 + 15	9	9	5 r
121	30.5	♂♀	25	33	58	15	16	3 + 16	9	9	6 r
122	30.5	♂♀	24	33	57	14	16	3 + 15	9	9	5 r
123	30.5	♂♀	25	32	57	14	15	3 + 16	9	9	5 r
124	26.2	♂♀	24	34	58	14	16	3 + 15	9	9	3 r
125	30.0	♂♀	24	33	57	14	15	3 + 14	9	9	5 r
126	25.5	♂♀	24	33	57	13	16	3 + 16	9	9	4 r
127	30.0	♂♀	26	30	56	14	15	3 + 15	9	9	6 r
128	29.0	♂♀	24	33	57	14	15	3 + 15	9	9	5 r
129	31.0	♂♀	25	32	57	13	16	3 + 15	9	9	5 r
130	30.0	♂♀	24	33	57	15	16	3 + 15	9	9	5 r
131	30.8	♂♀	25	32	57	15	16	3 + 17	9	9	6 r
132	29.0	♂♀	24	32	56	14	15	3 + 15	9	9	5 r
133	29.8	♂♀	23	34	57	14	15	3 + 15	9	9	6 r
134	29.5	♂♀	24	33	57	15	15	3 + 15	9	9	6 r
135	30.2	♂♀	24	33	57	14	15	3 + 15	9	9	5 r
136	29.0	♂♀	25	32	57	14	15	3 + 14	9	9	6 r
137	30.8	♂♀	25	32	57	14	15	3 + 15	9	9	6 r
138	30.3	♂♀	24	33	57	14	14	3 + 14	9	9	ca. 4 r
139	29.6	♂♀	24	32	56	13	16	3 + 14	9	8	5 r
140	29.7	♂♀	25	33	58	14	15	3 + 16	9	9	5 r
141	27.5	♂♀	25	32	57	15	16	3 + 15	9	9	4 r
142	29.2	♀	24	33	57	14	15	3 + 14	9	9	6 r
143	31.0	♀	25	33	58	13	16	3 + 15	9	9	5 r
144	29.9	♀	24	33	57	13	15	3 + 16	9	9	5 r
145	30.0	♂	24	33	57	14	15	3 + 15	9	9	5 r
146	30.5	♂	24	33	57	15	15	3 + 14	9	9	5 r

No.	Length cm	Sex	Vertebrae: Precaudal	Vertebrae: Caudal	Vertebrae: Total	Keeled scales K_2	Branched rays in dorsal fin	Rays in anal fin	Rays in ventral fins: right	Rays in ventral fins: left	No. of winter-rings in scales approxim.
147	28.7	♂♂♂♂♂♀♀♀

Age and Lengths of mature Spring Spawners from Cape Wrath and North of Flugga (p. 111—114).

Cape Wrath March 5. 1923.

Length cm.....		26	27	28	29	30	31	32	33	Total No. of specimens	Average length cm	+ 0.5
Year class	No. of winter rings											
1919	4	1	..	4	..	..	..	..	..	5	27.60	28.10
1918	5	..	3	29	83	65	7	..	..	187	29.24	29.74
1917	6	1	1	2	15	12	1	2	..	34	29.32	29.82
1916	7	..	1	3	1	7	1	2	1	16	29.88	30.38
1915	8	..	..	..	..	..	1	2	1	4	32.0	32.5
1914	9	..	..	..	..	..	1	..	..	1	31.0	31.5
..	ca. 5	..	1	2	2	4	..	..	..	9	29.0	29.5
..	ca. 6	..	..	..	1	..	3	..	..	4	30.5	31.0
..	ca. 7	..	..	..	..	2	..	..	1	3	31.0	31.5
..	ca. 8	..	..	1	..	1	..	1	..	3	30.0	30.5
..	?	..	..	1	1	1	..	1	..	4	29.75	30.25
	Total....	2	6	42	103	92	14	8	3	270	..	..

North of Flugga. March 21. 1923.

Length cm.....		25	26	27	28	29	30	31	32	33	Total No. of specimens	Average length cm	+ 0.5
Year class	No. of winter rings												
1920	3	..	1	..	..	..	..	..	..	..	1	26.0	26.5
1919	4	3	..	2	2	8	..	..	..	..	15	27.80	28.30
1918	5	2	3	7	40	97	58	8	1	..	216	29,03	29,53
1917	6	..	..	..	1	15	20	3	..	..	39	29.64	30.14
1916	7	..	..	..	1	3	3	..	..	1	8	29.75	30.25
1915	8	..	..	..	..	2	..	..	..	2	4	31.00	31.5
..	ca. 3	..	..	..	..	..	1	..	..	..	1	30.0	30.5
..	ca. 4	..	..	..	..	1	1	..	..	..	2	29.5	30.0
..	ca. 5	..	..	..	1	1	1	1	..	..	4	29.5	30.0
..	ca. 6	..	1	..	2	1	..	1	1	..	6	29.0	29.5
..	ca. 7	..	..	..	..	1	1	..	..	..	2	29.5	30.0
..	ca. 8	..	..	..	..	..	..	..	1	..	1	32.0	32.5
..	?	..	..	..	..	1	..	..	..	..	1	29.0	29.5
	Total....	5	5	9	47	130	85	13	3	3	300	..	..

List of Tables of Analyses of Herrings caught in the North Sea and the Skagerak.

Page

A. Herrings from the Shetlands Isles. Sept. 1. 1921 97
B. Young Herrings from S. W. of Graadeep. Nov. 30. 1922 99
C. Herrings from N. W. of Hirshals. March 6. 1923 100
D. Young Herrings from E. of Hanstholm. Aug. 23. 1921 104
E. Herrings from W. by S. of Vinga. Febr. 10. 1915 104
F. Herrings from N. of Skagen. March 17. 1915 105
G. Herrings from 3 miles N. of Skagen. Jan. 5. 1924 107
H. Herrings from N. W. of Skagen. Jan. 26. 1924 109
I. Herrings from 12 miles W. of Cape Wrath. March 5. 1923 111
K. Herrings from 9 miles N. of Flugga. March 21. 1923 113

List of Literature.

Andersson, K. A.: Undersökningar rörande det Bohuslänske sillfisket. — Svensk Fiskeri-Tidskrift. 1916.

Bjerkan, Paul: Age, Maturity and Quality of North Sea Herrings during the years 1910—1913. — Report on Norwegian Fishery and Marine Investigations Vol. III. No. 1. Bergen 1917.

Boeck, Axel: Beretning om Sildefisket ved den norske og den bohuslenske Kyst. — Tidsskrift for Fiskeri. 5te Aarg. 1870.

— Det bohuslenske Sildefiskeries Historie. — Nordisk Tidsskrift for Fiskeri. 1. Aarg. 1874.

Boecke, J.: Eier und Jugendformen von Fischen der suedlichen Nordsee. — Verh. uit het Rijksinstituut voor het Onderzoek der Zee. Eerste Deel IV. 1906.

Borley, J. O. and Russell, E. S.: Report on Herring Trawling. — Fishery Investigations. Ser. II. — Sea Fisheries. Vol. IV. No. 4. London 1922.

Bowman, Alexander: Spawny Haddocks. The Occurrence of "Spawny" Haddock and the Locus and Extent of the Spawning Grounds. — Fisheries, Scotland, Sci. Invest. 1922. IV. April 1923.

Broch, Hj.: Norwegische Heringsuntersuchungen während der Jahre 1904—1906. — Bergens Museums Aarbog 1908. No. 1.

— Förteckning öfver Göteborgs Museums sillsamlingar etc. — Svenska Hydrografisk-Biologiska Kommissionens Skrifter III. 1908.

Brown, C. H.: Report on the Deep Currents of the North Sea as ascertained by Experiments with Drift Bottles. — North Sea Fisheries Invest. Committee. Fourth Report (Northern Area). Hydrography. London 1909.

Böhnecke, G.: (v. Schumacher).

Canu, Eugène: (v. Sauvage et Canu).

Cligny, M.: Contribution à l'étude biologique du hareng. — Annales de la Station de Boulogne-sur-Mer. Vol. I. 1905.

Cowan, Dorothy: (v. Storrow & Cowan).

Dahl, Knut: The scales of the Herring as a means of determining Age, Growth and Migration. — Report on Norwegian Fishery and Marine Investigations Vol. II. 1909. No. 6.

Danois Le, Ed. et Henri Heldt: Les Harengs des Smalls et les Conditions hydrologiques de leurs migrations. — Notes et Mémoires Nr. 36. Office Sci. et Tech. d. Pêches Maritimes. Paris. Janvier 1924.

Delsman, H. C.: Über das Wachstum von Nordseehering und Zuiderseehering etc. — Rapporten en Verhandelingen uitg. door het Rijksinstitut voor Visscherijonderzoek Deel I. Afh. 2. 1914.

Duge: Heringseier im Magen der Schellfische. — Mitteilungen d. deutschen Seefischerei-Vereins, 1903 p. 460.

Duncker, Georg: Über einige Lokalformen von Pleuronectes platessa L. — Mitteilungen aus dem Naturhistorischen Museum. XXX. Hamburg 1913.

Ehrenbaum E.: Eier und Larven von Fischen der deutschen Bucht III. — Wissensch. Meeresuntersuchungen N F. VI. Bd. Abt. Helgoland 1904.

Ueber den Elbhering. — Der Fischerbote. März 1911.

Entwicklung und jetziger Stand des deutschen Trawlherings-Fanges. — Der Fisherbote. Septbr. 1923.

Ehrenbaum, E. und Peters, N.: Ueber den Trawlhering. — Der Fischerbote 1922 Nr. 11.

Ekman, G., Otto Pettersson, F. Trybom: Resultaten af den internationella hafsforskningens arbete under åren 1902—1906. — Stockholm 1907.

Ewart, J. Cossar: Natural History of the Herring. — Report II Fishery Bd. Scotl. for 1883. Edinburgh 1884.

Fulton, T. Wemyss: The Chief Fishing Grounds on the East Coast of Scotland. — Report IX. Fishery Board for Scotland. Edinburgh 1891.

— The Currents of the North Sea and their Relation to Fisheries, ibd. Report XV, Edinburgh 1897.

Gehrke, J.: Über die Sauerstoff-Verhältnisse der Nordsee. — Ann. d. Hydr. 1916.

Heincke, Fr.: Die Varietäten des Herings. — Jahresb. d. Komm. z. wiss. Unters. d. deutschen Meere in Kiel, Jahrg. IV—VI, 1874—76. 1876.

— Die Varietäten des Herings II Teil. — IV. Jahresb. der Komm. z. wiss. Unters. d. deutschen Meere in Kiel, Jahrg. VII—XI, 1877—81. 1882.

Naturgeschichte des Herings I. — Die Lokalformen und die Wanderungen des Herings in den europäischen Meeren. — Abhandlungen d. deutschen Seefischerei-Vereins. Bd. II. Berlin 1898.

Heldt, Henri: (v. Ed. Le Danois).

Hjort, Johan: Norsk Havfiske. Norges Fiskerier, I. — Bergen 1905.

— Report on Herring Investigations until January 1910. — Publications de Circonstance No. 53. 1910.

Jacobsen, J. P.: Mittelwerte von Temperatur und Salzgehalt .... in dänischen Gewässern. — Medd. Komm. f. Havunders., Serie Hydrografi. Bd. 1 No. 10. 1908.

Jee, Edwin C.: Lightship Observations. Board of Agricult. and Fisheries. — Fishery Investigations. Series III, Vol. II. London. 1919.

— The English Channel. — Board of Agriculture and Fisheries. Fishery Investigations, Series III, Vol. I. London. 1919—1921.

Jenkins: The Difference between Spring and Autumn Herring. — Report for 1902 Lanc. Sea Fish. Lab. Liverpool 1903 (cited after Williamson, 1914).

Jespersen, P.: On the occurrence of the postlarval stages of the Herring and the "Lodde" (*Clupea harengus* L., and *Mallotus villosus* O. F. M.) at Iceland and the Faroes. — Medd. Kommissionen f. Havundersøgelser, Ser. Fiskeri. Bd. VI. No. 1. 1920.

Johansen, A. C.: Bericht über die dänischen Untersuchungen über den Schollenbestand etc. — Medd. Komm. f. Havundersøgelser. Ser. Fiskeri. Bd. III. Nr. 8. 1910.

— Om Sildens Vandringer. — Dansk Fiskeritidende No. 7. 1915.

— Om Sildebestanden og Snurpenotfiskeriet i Farvandene omkring Danmark. — Dansk Fiskeritidende No. 9. 1916.

— On the Large Spring-Spawning Sea Herring (*Clupea harengus* L.) in the North-West European Waters. — Medd. Kommissionen f. Havundersøgelser. Ser. Fiskeri. Bd. V. No. 8. 1919.

— On the Summer-Spawning Herring (*Clupea harengus* L.) of Iceland. — ibd. Bd. VI. No. 3. 1921. (a).

— The Atlanto-Scandian Spring Herring spawning at the Faroes. — ibd. Bd. VI. No. 4. 1921. (b).

— Ueber die Winterheringe des Kattegats. — Festschrift für Friedrich Heincke. Nr. 12. 1923. Wiss. Meeresunters. N. F. XV. Bd. Abt. Helgoland.

Keilhach, Ludwig: Rassen-Untersuchungen an Nordsee-Schollen. — Wiss. Meeresunters. deutschen Meere. N. F. X. Bd. Abt. Helgoland. Oldenburg in Gr. 1913.

Knudsen, Martin: Résumé de l'hydrographie des mers explorées par le conseil. — Conseil Permanent Internat. Bulletin des Resultats etc. Année 1906—1907. Partie supplémentaire. København 1909.

Kyle, H. M.: Contributions towards the Natural History of the Plaice. — 18. Report. Fishery Board for Scotland. — Glasgow 1900.

— Monthly Data and Charts over the Herring Fishery in 1903. — Bulletin Statistique. Vol. I. 1906.

Lea, E.: On the Methods used in the Herring Investigations. — (See Hjort's Report in Publications de Circonstance No. 53 1910).

— Report on "Age and Growth of the Herring in Canadian Waters". — Canadian Fisheries' Expedition 1914—15. Ottawa 1918.

Ljungman, A. V.: Om sillens och skarpsillens fortplantning och tillväxt. — Nordisk Tidsskrift for Fiskeri 5. Aarg. 1879 (a).

— Bidrag till lösningen af frågan om de stora sillfiskenas sekulära periodicitet. — ibd. 1879. (b).

— Om sillens och skarpsillens racer med serskild hänsyn till Sveriges vestkust. — Nordisk Tidsskr. f. Fiskeri 6. Aargang 1881 & 7. Aargang 1882.

Masterman, A. T.: On the Rate of Growth of the Food Fishes. — Report XIV. Fishery Board for Scotland. Edinburgh 1896.

Matthews, J. Duncan: Report as to Variety among the Herrings of the Scottish Coasts. — Part I & II. Reports Fishery Bd. Scotl. 4th and 5th for 1885 and 1886.

Meek, Alexander: Herring Races. A. Morphological Features. — Report Dove Marine Laboratory. 1914.

— Summary and General Report. — Report Dove Marine Laboratory. 1919.

Mitchell, J. M.: The Herring. Its Natural History and National Importance. — Edinburgh 1864.

Molander, Arvid, R.: Studies in the Growth of the Herring etc. — Svenska Hydrografisk-Biologiska Kommissionens Skrifter VI. 1918.

Nilsson, S.: Skandinavisk Fauna. — IV. Fiskarna. Lundae 1855.

Orton, J. H.: An account of the Researches on Races of Herrings. — Journal Marine Biol. Association. Plymouth, N. S. Vol. XI. No. 1. 1916.

Paulsen, Ove: Studies on the Biology of *Calanus finmarchicus* in the Waters round Iceland. — Medd. Komm. f. Havunders., Ser. Plankton Bd. I. No. 4. 1906.

Peters, N.: (v. Ehrenbaum, E., und Peters, N.).

Petersen, C. G. Joh.: De danske Farvandes Plankton i Aarene 1898—1901. I. — K. Danske Vid. Selsk. Skrifter. 6. R. nat. & mat. Afd. XII 3. København 1903.

Pettersson, Otto, och Gustaf Ekman: Grunddragen af Skageraks och Kattegats hydrografi. — Kgl. Sv. Vet. Akad. Handlinger. Bd. 24. Stockholm 1891. (See also: G. Ekman, O. Pettersson, F. Trybom).

Pettersson, Otto: Studien über die Bewegungen des Tiefenwassers und ihren Einfluss auf die Wanderung der Heringe. — Der Fischerbote 1911, No. 7, 8, u. 9.

— Kosmiska orsaker till rörelserna uti hafvets och atmosfärens mellanskikt. — Svenska Hydrografisk-Biologiska Kommissionens Skrifter, vol. VII. 1922.

Redeke, H. C.: Bijdrage tot de Kennis van de Noordzee-Haringstammen. — Rapporten en Verhandelingen uitgegeven door het Rijksinstituut voor Visscherijonderzoek. Deel I. Afl. 4. 1918.

Redeke, H. C. und P. J. van Breemen: Die Verbreitung der planktonischen Eier und Larven einiger Nutzfische in der suedlichen Nordsee. — Verhandelingen uit het Rijksinstituut voor het Onderzoek der Zee. Deel II. 1907—1908.

Rosén, N.: Det bohuslänske fiskets nuvarande laga. — Lysekil 1920.

Russell, E. S.: Report on Market Measurements in relation to the English Haddock Fishery during the years 1909—1911. — Fishery Investigations. Series II. — Sea Fisheries. Vol. I. Part I. London 1914.

— (v. Borley, J. O. and Russell, E. S.).

Sauvage et Canu: Le hareng des côtes de Normandie en 1891 et 1892. — Annales de la Station Aquicole de Boulogne-sur-Mer. Vol. 1. 1892.

Schmidt, Johs.: Fiskeriundersøgelser ved Island og Færøerne i Sommeren 1903. — Skrifter, Komm. f. Havunders., No. 1. København 1904.

— First report on eel investigations. — Rapports et Procès-Verbaux Cons. perm. internat. Vol. XVIII. 1914.

— Second report on eel investigations. — ibd. Vol. XXIII. 1916.

Racial Investigations I, *Zoarces viviparus* L., and local races of the same. — Comptes-rendus des travaux du Laboratoire de Carlsberg. 13 vol. 1917. (a).

Racial Investigations II. Constancy Investigations continued. — ibd. vol. 14, No. 1. 1917. (b).

— Racial Investigations III. Experiments with *Lebistes reticulatus* (Peters) Regan. — ibd. vol. 14. No. 5. 1919.

Racial Investigations V. Experimental investigations with *Zoarces viviparus* L. — ibd. Vol. 14. No. 9. 1920.

Racial Investigations. VII. Annual Fluctuations of Racial Characters in *Zoarces viviparus* L. — ibd. vol. 14, No. 15. 1921.

Schott, G.: Geographie des Atlantischen Oceans. — Hamburg 1912.

Schumacher, A.: Die Oberflächenströmmungen in der Nordsee, nach G. Böhnecke. — Der Fischerbote. Heft 12. 1923.

Sherriff, Catherine: Herring Investigations. — Fisheries, Scotland, Sci. Invest. 1922 I (Sept. 1922).

Smitt, F. A.: Om sillracernes betydelse. — Bihang till K. Svenska Vet. Akad. Handlingar, Bd. 14. Afd, IV No. 12. Stockholm 1888.

Storrow, B. & Dorothy Cowan: Herring Investigations I & II. — Dove Marine Laboratory. Report for the Year ending June 30th. 1920.

Sæmundsson, Bjarni: Oversigt over Islands Fiske. — Skrifter. Komm. for Havunders. No. 5. København 1908.

Thompson, D'Arcy Wentworth: Report on the Salinity of the North Sea. — North Sea Fisheries Invest. Committee. Fourth Report (Northern Area). Hydrography. London 1909.

Thompson, D'Arcy W. & Catherine Sherriff: Herring Investigations. — Fisheries Scotland, Sci. Invest. 1922 I (Sept. 1922).

Trybom, Filip: Iakttagelser vid sillfisket i Bohuslän vintrarne 1880—81 och 1881—82. — Nordisk Tidsskrift for Fiskeri. 7. Aarg. 1882.

— (v. G. Ekman, O. Pettersson, F. Trybom).

Törlitz, Heinrich: Anatomische und entwicklungsgeschichtliche Beiträge zur Artfrage unseres Flussaales. — Zeitschrift für Fischerei, 21. Bd. Heft 1—2. Berlin 1922.

Williamson, H. Charles: A short Résumé of the researches into the European Races of Herrings. — Fisheries, Scotland Sci. Invest. 1914. I (April 1914).

Wood, Henry: Observations on the Scottish Summer Herring Fishing of 1922. — Fisheries, Scotland, Sci. Invest. 1923. No. II. June 1923.

LIST OF FIGURES

Page

Fig. 1. Catch of herring larvae per 30 minutes' haul with Petersen's Young Fish Trawl in September-November 1903—06 and September-October 1922 28

— 2. Catch of herring larvae per 30 minutes' haul with Petersen's Young Fish Trawl in September-October 1922 29

3. Catch of herring larvae with vertical hauls by Hensen Net, per m^2 30

4. No. of herring larvae of autumn spawners caught in the spring months per 30 minutes during the Danish fishing experiments by Petersen's Young Fish Trawl 31

— 5. View of the mean surface currents of the North Sea. After Böhnecke 1922 32

6. Maximum temperature for the year at the sea bottom and the approximate situation of the spawning places of the summer and autumn spawning herrings of the North Sea 39

7. Mean temperature for August at the sea bottom and the approximate situation of spawning grounds of the summer spawning herrings in the northern part of the North Sea, after Bowman, Wood and Bjerkan 40

8. Mean temperature for August at 40 m depth, and the approximate situation of the principal north-western spawning places for the Bank Herring, after Fulton 41

9. Mean temperature for November at 40 m and the approximate situation of important spawning grounds for the Bank Herring on the Dogger Bank and the area between the Dogger Bank and the English Coast 42

10. Mean salinity for the year at the sea bottom, and the approximate situation of the spawning places of the summer and autumn spawning herrings of the North Sea 44

11. Mean temperature and salinity in the Kattegat on November 1st, and the position of the observed spawning places for the Autumn Herrings of the North Eastern Kattegat 50

12. The yield of the Herring Fishery from Bohuslän in the period from 1860—1923. After Otto Pettersson 61

13. Average number of Keeled Scales (K_2) observed in Summer- and Autumn-Spawning Herrings of the North Sea 82

14. The main direction of the Currents in the intermediate layers (c. 30—100 m) of the Skagerak and the lower layers of the Kattegat and Belt Sea 87

— 15. The main distribution of the Bank Herring of the North Sea and the situation of important fishing places where this Herring is predominant 96

CONTENTS

		Page
I.	Introduction	3
II.	The Shetland Summer Herrings	5
III.	The Scotch Summer Herring	12
IV.	The Dogger Bank Herring	13
V.	The Jutland Bank Herring	17
VI.	Autumn Herrings from the German Bight	18
VII.	General Survey of the Racial Characteristics of the Summer- and Autumn-Spawning Herrings of the North Sea	21
VIII.	Age and Size of mature Summer- and Autumn-Spawning Herrings from different parts of the North Sea	22
IX.	On the Position of the Spawning Grounds of the Summer- and Autumn-Spawning Herrings of the North Sea	25
X.	On the Temperature and Salinity at the Spawning Places of the Summer- and Autumn-Spawning Herrings of the North Sea	34
XI.	On the Differences between the Bank Herring of the North Sea and various other Herring Races in the North Sea and adjacent waters, viz.	43
	A. The Autumn-Spawning Herrings of the North Eastern Kattegat	45
	B. The Winter-Spawning Herrings of the Kattegat	51
	C. The Atlanto-Scandian Herring	51
	D. The Scotch Spring Herring	51
	E. The Channel Sea Herring	56
	F. The West Channel Winter Herring	58
XII.	Are the Summer- and Autumn-Spawning Herrings of the North Sea of importance for the great Winter Fishing in the Eastern Skagerak?	60
	A. The Herring Fishery in the Eastern Skagerak	60
	B. Which Herring Races are predominant at the present time in the open waters of the eastern Skagerak during the Winter?	62
	C. Which Herring Races are predominant in the Skärgård and Fiords of Bohuslän during the periods of poor fishing?	78
	D. Which Herring Races are predominant in the Skärgård and Fiords of Bohuslän during the periods of rich fishing?	79
	E. General Survey of the "foreign" Herring Races occurring in the Eastern and Southern Skagerak during the Winter	81
	F. Otto Pettersson's explanation of the Annual and the Secular Periodicity in the Bohuslän Herring Fishery	85
XIII.	General Remarks about the Herring Races	88
	Tables of the Analyses of Herrings caught in the North Sea and the Skagerak	97
	List of Literature	116
	List of Figures	118

550. 5/VII 24.

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